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Evening Meeting.

Monday, February 15, 1875.

CAPTAIN THE RIGHT HON. LORD GILFORD, R.N., Lord of the
Admiralty, in the Chair.

NAMES of MEMBERS who joined the Institution between the 2nd and 15th
February, 1875.

LIFE.

Wing, H. Tryon, Lieut., 97th Regiment.
Watkin, H. S. Spiller, Lieut., R.A.

ANNUAL.

Seccombe, John W., Captain R.N.	Lloyd, Arthur C., Lieut. 45th Regiment.
Gunter, Edwd., Captain 69th Regiment.	Owen, F. H. E., Capt. R.M. Artillery.
Flood, J. C. H., Lieut., 19th Hussars.	Browne, E. C., Captain 21st R. N. B.
Laughton, J. K., Esq., M.A., R.N.,	Fusiliers.
Naval Instructor, Royal Naval Col-	Greenaway, H. C., Captain 10th Bengal
lege, Greenwich.	Lancers.
Sloggett, W. H., Dep. Inspector General	Clarke, Stanley de A. C., Major 4th
of Hospitals and Fleets.	Hussars.
Burroughs, F. W., C.B., M.-Gen., Unattd.	Young, J. S., Dep. Commissary.

SCIENTIFIC INSTRUCTION IN THE NAVY.

By J. K. LAUGHTON, Esq., R.N., M.A., Mathematical and Naval
Instructor at the Royal Naval College.

IN accordance with the wish of your Council, I have undertaken to give you some account of the work which is being done in the Royal Naval College, and its general bearing on the scientific instruction of our Naval Officers. I am glad to have the opportunity of doing this, for though a great deal has been publicly said and written about "the higher education of Naval Officers," it is quite evident that a large

proportion of this has been said and written by persons who have a very vague idea of what is properly meant by the phrase, "higher education of Naval Officers," who entirely misunderstand the objects of the College, and who are utterly ignorant of the way in which we—the staff of instructors at Greenwich—are endeavouring to carry out those objects.

In establishing the Royal Naval College at Greenwich on its present footing, it was undoubtedly the wish and intention of the Admiralty to give the Officers of the various branches of our service increased facilities for studying certain subjects, the knowledge of which must make them more capable, and therefore more efficient.

The Admiralty Circular, dated the 30th January, 1873, announcing the establishment of the Royal Naval College at Greenwich, is reprinted in the "Navy List," and most of you are probably familiar with it. I will, however, recall to you that that Circular declares the College to be opened for—

1. Captains and Commanders.
2. Lieutenants.
3. Navigating Officers.
4. Naval Instructors.
5. Acting Sub-Lieutenants and acting Navigating Sub-Lieutenants.
6. Officers of the Royal Marine Artillery and of the Royal Marine Light Infantry.
7. Officers of the engineer branch of the Service, viz. :—
Chief Engineers.
Engineers.
1st class Assistant Engineers.
Acting 2nd class Assistant Engineers.
8. A limited number of dockyard apprentices, annually selected by competitive examination.
9. Private students of naval architecture or marine engineering.
10. Officers of the Mercantile Marine.

Of these 10 classes the students at the College are composed, and with reference to the course of studies pursued, are divided thus :—

Classes—

7	}	form Division A.
8		
9		
1	}	form Division B.
2		
3		
4		
6		
10		
5		forms a Division by itself.

¹ No Officers of this class have yet joined.

You will understand, then, that Division B includes all executive and navigating Officers above the rank of Sub-Lieutenant, Officers of the marine artillery and light infantry, and Officers of the mercantile marine. At the present time it consists of the following:—

Captains	3
Commanders	4
Lieutenants	65
Navigating Lieutenants.....	8
Captain R.M.A.	1
Lieutenants R.M.L.I.....	2
Lieutenants of Royal Marines qualifying for the Artillery.....	6
Probationary Lieutenants of Marines	9
Master in the Mercantile Marine.....	1
	—
Giving a total of.....	99

Considered from a naval point of view, this division is the most important. Material as the age is, we cannot forget that it is to our sailors, Officers and men, that we owe our past maritime greatness; and that it is to them, not to our engineers and naval architects, that we primarily trust for the future. I am taking the subject, then, strictly in the natural order, although in defiance of the conventional arrangement of the letters of the alphabet, and am going in the first place to speak exclusively of the studies of division B, and of the division of Sub-Lieutenants.

The scientific instruction of executive Officers is a point that has been widely and wildly discussed. It has been, and still is often maintained, that the Navy is a purely practical service; that a Naval Officer should be a purely practical man; and that any intermixture of theoretical knowledge must be injurious to him. It has been maintained that our old heroes would have scouted the idea of a Naval Officer having any tinge of literature or science. I have heard—is there any one here who has not heard—it said, “What would old Benbow have said to such a thing?” as if, forsooth, a runaway butcher’s apprentice is to be accepted as the ideal Naval Officer of the olden time; or as if the speakers had forgotten—perhaps I should say had never known—that, years before Benbow was born, Drake had shown that a man might be a skilful engineer as well as a bold seaman; Raleigh had shown how to write, as well as to act, history; and Grenville had shown that a courteous gentleman and finished scholar could fight like a Paladin, and die like a hero.

I am not here this evening to dwell on the teachings of our old history: I have alluded to them only because this oft-repeated Benbow argument seemed to call for it, by claiming a traditional acceptance of the overpowering value of mere practical seamanship. I am as ready as any one to acknowledge the vast importance of this practical seamanship; to insist that without it everything else which a Naval Officer may learn is worthless; to admit that it is to it, and in a great measure

to it alone, that our past glories are due; but I would none the less insist that our naval history would be still more brilliant had the necessity of combining scientific instruction with practical experience been more early recognised; and I would point distinctly to the fact that several of the deeds of former days, the memory of which the service loves to recall, are to be especially attributed to the then rare combination of theoretical knowledge and practical skill. It was no mere practical seamanship that annihilated the French fleet at the Nile; it was no mere practical seamanship that piloted the "Resolution" round the world and through unknown seas, without losing a man by scurvy, and that in an age when such ships as the "Centurion" commanded by thorough seamen, were simply pest-houses; or to speak of later days, it was no mere practical seamanship that got the "Gorgon" off that storm-lashed beach of sand and mud in the Bay of Monte Video. No! not mere practical seamanship, but practical seamanship, supplemented by a careful study and sound knowledge of tactics, navigation, hygiene, and mechanics.

I wish, then, at the outset, to declare war against the proposition that theoretical knowledge and practical skill are opposed to each other; a proposition that is often put forward, and more frequently, perhaps, by implication than in plain words. And it is not with practical men alone that the fault lies; vain and unscientific theory is an abomination of the age, and makes us sometimes think that the Island of Laputa has settled down on the western outskirts of Europe, and that the day may come when we are to be measured for our clothes by theodolite and tables of logarithms. But the model practical man, without being, perhaps, so utterly absurd, is a very helpless creature. He does as he has been told, and beyond that has not an idea. Faith, in matters religious, may be an excellent quality; but in matters scientific, it is the emblem of stupidity and ignorance, an enemy to knowledge, and a barrier to advancement.

Scientific study implies incredulity, an unwillingness to believe; and whatever the question studied may be, a man has not really mastered it until that incredulity, that unwillingness, has been fairly overcome by complete and exact investigation. It is thus that the attainable end, in so many branches of science, is merely doubt; it is thus that the rational acknowledgment of ignorance and incompetence is frequently the bound of human inquiry. This feeling of helplessness will scarcely, however, occur within the limits of what may properly be called naval education. In that, at least, we have well defined paths before us, paths which it is the duty of the instructor to point out, as a guide only, not as a conveyance; it is no part of an instructor's duty to carry the student over all difficulties, and set him down at the far end, without the faintest idea how he got there, or how the obstacles have been overcome.

Between the old system of leaving the student to find everything out for himself, and the new system which would give him nothing to find out, a mean, widely distant from either, must be struck; the aim of all teaching is not merely to impart a certain amount of knowledge, which must, from the necessary limit of time, be itself limited; it is rather

to cultivate a power of acquiring knowledge, a habit of disciplined thought, the results of which extend far beyond the bounds of any collegiate or university session—even to the utmost period of our lives.

This, then, is the principle on which scientific instruction must be based; and so-called instruction on any other basis, is not instruction, but *cram*. I am not going to detain you now with a discussion of the abominations of any system of cramming. I will not say it is unknown at the Royal Naval College, for wherever there are examinations, compulsory examinations especially, the many-headed monster will force himself in; but we do endeavour to keep the creature down; to devote ourselves to the work of instruction, accepting examinations as a necessary evil.

Having thus defined what we mean by instruction, I would ask your attention whilst we discuss the subjects in which instruction has to be given. Now these subjects must be as means to some end; they must be of such a nature as to assist the learner in attaining the desired end; but with the end itself, the instructor has, as a rule, nothing whatever to do. The carrying out that end is the afterwork of the instructed. I do not here speak of the direct technical and practical instruction which is given, not as mere instruction, but by compelling the learner to assist, subordinately, in the performance of some duty. Whatever is learned in this way alone, is learned without understanding, and the understanding, if ever got at all, must be got by some other means. It is these means, then, which form the subjects of that instruction of which I have now to speak. In our case, as in all others where the instruction is to be considered as a means to some well defined end, the choice of subjects is necessarily limited to those which relate to the end proposed; and in making that choice, the end must of course be kept very distinctly in view. But when the choice is once made, when the subjects are once determined on, the end which has guided that choice and ruled that determination may be for a while lost sight of; the intermediate course of instruction aims not at the original object, but at securing a sound and intelligent knowledge of the one particular subject.

It is therefore to this choice of the subjects which are now studied at the Royal Naval College that the principal interest belongs; and it is this choice which determines, not only in its broad outline, but in its minutest details, the character of the present more enlarged effort to establish the theoretical instruction of our Naval Officers on a scientific basis.

First of all then is the study of mathematics. There is no use attempting to shirk the many and difficult questions which arise on this point. It is argued that the study of mathematics is one, in itself, so engrossing, that no one who does not give to it much more time than a Naval Officer has at his disposal, can possibly make any real progress in it: that the devoting an important year to it is as if a man going to build a house were to spend all his money in setting up the scaffolding: that Officers, when they come to the College, are past the age when the study of mathematics can be advantageously commenced:

that if a man has attained mature years and high service rank he has no disposition to plod, for the first time in his life, through the elements of Euclid or algebra: that the idea of making Naval Officers a body of skilled mathematicians is both vain and useless: and in fine, that the time might be much better employed.

Now these and such like arguments must be considered, for they have been put forward by men whose opinions have, and deservedly have, very great weight; but it seems to me that they have been urged in some cases hastily, in others incorrectly, in others even ignorantly. I do not, for instance, suppose that it ever, for one moment, entered the heads of those on whom the organization of the College devolved that all Naval Officers should become skilled mathematicians; but certainly if they ever did entertain such a wild idea, a very short experience must have been sufficient to dispel it. None the less, they have decided, and I think decided rightly, that, so far as possible, a certain amount of mathematics should be read by every Officer who joins the College. It is not therefore necessary to suppose that they have acted in ignorance of the impossibility of men advancing, in the course of a few months, beyond the very threshold.

But, you will perhaps say, that is the very point of the argument: if men cannot possibly, in the time, attain a competent knowledge of mathematics, what is the use of a mere smattering? Well, then, we do not aim at a mere smattering. Our wish is that the mathematical knowledge acquired should be sound, so far as it goes, however short the distance may be. To what use then? Certainly not to apply it in independent investigations; barely perhaps to enable the student, in after years, to follow the meaning of the more abstract treatises which relate to the subjects he is interested in.

There are, however, certain most important branches of naval science, such as navigation, nautical astronomy, and surveying, in which nothing, absolutely nothing, can be done without some knowledge of mathematics; and whoever studies these subjects on any non-mathematical basis does so, not scientifically, but empirically, or, as it is more commonly called, by rule of thumb. But the amount of mathematical knowledge absolutely required for this is small. Most of the important problems in surveying are based on the Third Book of Euclid, and nautical astronomy demands no more than an acquaintance with the leading propositions in spherical trigonometry; so that really a great deal of practical knowledge can be established on a scientific basis with this very small amount of mathematics.

I do not, however, think that even the advance towards these subjects, valuable as it is, is the most important result of our mathematical study, or is the object more especially in view in prescribing it. I think rather the object is to cultivate that power of concentrating the mind, which to very few is a gift of nature, but which the study of mathematics, more markedly than any other study, may develop or enlarge. Pray do not go off with the idea that I, as a mathematical instructor, am merely saying this on the principle that "there is nothing like leather." I would not be understood as saying that an advanced knowledge of mathematics is a necessary part of a liberal

education; but I do say that, for cultivating an exact and accurate tone of thought, a certain amount of mathematical training is indispensable.

I am here speaking, you will observe, of the advantages of mathematical study on the lowest and most general grounds; advantages which it offers to every one who will honestly apply himself to it. There are, of course, some who are not disposed to do so, whose minds have hardened down into other grooves, and whose age and standing in the Service are considered as giving them both a capability and a right to judge for themselves.

The rule, then, of devoting a considerable portion of the time to mathematical studies, which has been made absolute for junior Officers and for Lieutenants, has been left optional for Commanders and Captains; these are indeed advised to follow the general course, but if that is positively distasteful to them, they are at liberty to occupy themselves with more practical studies.

On the other hand, there are more than a few who, having a natural aptitude for mathematics, and having previously passed through the elementary drudgery, can and do attain a very respectable proficiency, and carry away with them a knowledge, and a trained power of acquiring knowledge, which may afterwards lead to very valuable results.

The recent alterations in the scheme for the examination of Sub-Lieutenants, which will enforce on all, as midshipmen, a greater degree of attention to the mathematical subjects than has hitherto been common, will necessarily, in future years, do away with a certain portion of the elementary work which has now to be gone through at the College; will give our students a better start, enabling them in fact to begin at the point where most of them now end. This is a consideration which we cannot and do not lose sight of, and which renders us hopeful that, before very long, the numbers of the more advanced minority will be considerably increased, and that the very irksome work of those who will always, in the nature of things, form the majority, will be considerably alleviated.

Still more hopeful shall we be if the Admiralty shall ever see fit to make a very decided change, either in the age for the entry of naval cadets, or in the system at present pursued on board the "Britannia."

The objections to increasing the age of entry are manifold; and though from a purely theoretical point of view, I would be inclined to wish that they could be overcome, the weight of authority and antecedent opposed to such a change is almost overwhelming; at any rate, I think very decidedly that it would be worse than rash to ignore all past experience, all history, until it has been more clearly shown than it has been, up to the present time, that the change is necessary. The report of the Naval Cadets' Committee recently issued, recommends, rather, a sweeping change in the system followed out on board the "Britannia." I wish for a moment to call your attention to some of these recommendations.

"We are of opinion," say the Committee, "that the brains of the 'cadets are overtaxed, not by the amount of time devoted to study,

"but by the excessive number of subjects and the system of 'cramming' and over-examination thereby necessitated.

"We are of opinion that the number of subjects studied is too great to allow of any being thoroughly mastered, and that the knowledge acquired, especially in the English subjects, viz., history, scripture-history, geography, grammar, and literature is of the kind which taxes the memory rather than the reason.

"The course of mathematical study, though far more thorough than that in English subjects, appears to us to fall short in like manner of the position it ought to attain, both as a means of mental training and as a grounding in mathematical knowledge. Both the habit of accurate reasoning and the possession for practical purposes of considerable scientific attainments are so important to Naval Officers, that it is most desirable they should receive, when young, a thorough grounding in those subjects, without which a knowledge of the higher mathematics cannot afterwards be acquired."

With these principles I heartily agree. Except in rare instances and under peculiar circumstances, if a good foundation of mathematical knowledge is not laid before a boy is sixteen, it will never be laid at all; and if the Admiralty really desires to increase largely the number of capable mathematicians amongst the Officers of the Service, or to work up the few to a higher standard, the change must be made at the beginning, it cannot be thrust in at the end. I again quote from this report.

"As a consequence of the imperfect grounding received by many cadets, even in the more important subjects, much that is learnt on board the 'Britannia' is speedily forgotten, and has to be re-acquired under the Naval Instructor of the sea-going ship to which the cadet is appointed. The midshipman, instead of learning seamanship and the duties of an Officer, and having a reasonable amount of leisure, has to devote his time to elementary studies which ought to have been firmly fixed in his mind years before, and too often acquires a dislike for a profession which appears to him rather that of a school-boy than of an Officer.

"We cannot consider any system of training successful which does not relieve the midshipman from the necessity of devoting his main thoughts and time to mere school duties."

The Committee is thus led to recommend that, amongst other important changes, the course of training should be extended to three years, that the "cram" subjects already spoken of should be done away with, and that the mathematical subjects should be taught in a more thorough manner than is now possible. Boys entering between the ages of twelve and thirteen would therefore pass out into sea-going ships between the ages of fifteen and sixteen, having a good groundwork of elementary mathematics, and able to devote themselves almost exclusively to their duties as Officers and young sailors.

That the Committee should have expressed an opinion so thorough-going and outspoken as this, is in itself a great triumph for those who have for years past protested against the course of cramming which has been carried out on board the "Britannia." I believe that the

opinion so expressed will find an echo in the heart of every Naval Instructor in the Service, and that the proposed scheme will commend itself as striking at the very root of the evil. I do not know that the Admiralty have as yet determined to follow out these proposals; if they should do so, and if they should be fortunate enough to secure as Chief Instructor a man such as the Committee speak of, a man of ability and energy and experience, the results in favour of sound education will be incalculable.

I have already said that to Commanders and Captains, the mathematical course at the College is quite optional; as a matter of fact, those whose inclinations do not lead them to it, avoid it. But for all ranks of voluntary students the time devoted to mathematical study has been very much overstated by common report, a report which I would wish to correct, as it may possibly tend to prevent Officers, senior Officers more especially, from joining as readily as they otherwise would. In reference to this I would quote an article in the last number of "Naval Science":—

"To submit Officers of rank of the mature age of thirty years and upwards to one procrustean course of elementary mathematics, to the acquisition of which their previous career has quite unfitted them, which must necessarily consume the most valuable portion of their 'nine months' residence, seems to us a height of absurdity for which even our present illogical system had hardly prepared us."

With all this I quite agree; it would be a height of absurdity; but I do not know that such a height has yet been reached anywhere; certainly it has not been reached at the Royal Naval College.

Evidently the information on which the writer of this article has based his statement has been imperfect and incorrect; and it is necessary to call attention to this, because as the article has been published under the auspices of the late Director of Education, it has been considered as embodying his views, and as based on his official knowledge.

Now, it is a very old proverb that there is no smoke without fire, and as this report, which the writer of this article in Naval Science has adopted, has been generally spread abroad, has been very generally believed, and has, to some extent at least, proved injurious, I think it will be well for me, having this opportunity, to trace out the fire which caused this smoke; show you that it was a very harmless fire after all, and that a bucketful of water thrown over it has long since extinguished it. To do this, it will be necessary to speak of the early days of the College.

It is exactly two years since the College was first opened for the reception of a few Gunnery Lieutenants, who were finishing or going through the old course, as it had been long prescribed at Portsmouth. The alterations in the building were very far from complete; workmen infested most of the rooms and passages; and bricks and mortar, shavings and sawdust, whitewash and paintpots were the signs of material progress and very material discomfort; but it had been determined that the College should be opened on the 1st of February, 1873, and it was opened.

With the Gunnery Lieutenants of whom I have spoken, I myself, as

their Instructor, was also transferred from Portsmouth; and for five months no other Instructor of any sort was appointed, except, indeed, the Instructor of Fortification, whose duties lay entirely with the Gunnery Lieutenants. But meantime, a great number of Half-pay Officers, understanding that the College was opened, applied to join, and were appointed. These, then, were placed under my instruction; my time was already very fully occupied, and I was directed simply to do the best I could without trenching on my primary duties as Instructor of the Gunnery Lieutenants. More joined, many more than were, I believe, at first expected: there were no Instructors except myself, and even if there had been, there was no room ready for them; there was thus nothing taught but mathematics, and that in a very broken and unsatisfactory manner. The Officers who had joined the College, probably in the expectation of finding it in full working order, were naturally a good deal disappointed; and it was at that time, and under such circumstances, that the report went abroad that mathematics—nothing but mathematics, was thought of or allowed.

But however true the report may have been, and to some extent was, in its origin, it is not true now. The hours appointed for organised study under the different Instructors are thirty-three in the week; of these sixteen are devoted to mathematics; the other seventeen are provided for at the option of each individual Officer; and whilst some elect to work on at mathematics, more especially the Gunnery Lieutenants, whose certificate, as such, depends almost entirely on the mathematical part of the examination, by far the greater number of Half-pay Officers apply the time to physics, chemistry, drawing, fortification, surveying, cartography, meteorology, international law, languages, or steam. There are also lectures on subjects connected with ship-building, such as applied mechanics, or stability of ships, which they are at liberty to attend.

Now, the thirty-three hours per week of which I have spoken is simply the time appointed for lectures or personal instruction; it does not represent thirty-three hours of solid work, and is not supposed to represent the whole time devoted to study; every Officer who joins the College with the real earnest intention of work may add to it as many hours as he can; and I think I am within very moderate bounds when I say that every Officer may and ought to have an average of twelve hours weekly. That is, however, at his own discretion; and if he chooses to spend the time rather at balls or theatres, he has certainly no right to accuse the College if the results at the end of the session are commensurate.

I consider, then, that we fairly claim from each earnest student forty-five hours in the week, of which sixteen are given to lectures and personal instruction in mathematics, seventeen to lectures and personal instruction in such other subjects as he may prefer, and twelve to private study at his own discretion.

I have thought that I might here properly introduce some account of the results of the examination held last June, at the end of our first Session. The marks were allotted to the different subjects as follows:—

Mathematics	3000
Physics	700
Chemistry	700
Steam	400
Marine surveying	300
Fortification.....	400
Military surveying and drawing	400
International law	250
Languages:—	
French	400
German.....	350
Spanish.....	350
	1100
Freehand drawing	100
	<hr/>
Total	7350

The number of marks obtained by the first four run thus:—

- (1.) 3614, of which 2465 for mathematics.
 (2.) 3301, of which 2418 for mathematics.

These were both Gunnery Lieutenants, and, as I have said, their special certificate is made, by Admiralty Order, to depend almost entirely on their mathematical numbers. Closely following these, however, we have—

- (3.) 3245, of which 1543 for mathematics.
 (4.) 3124, of which 1444 for mathematics.

These two were Half-pay Officers, who preferred making their numbers in other subjects; and as bearing directly on what I have been saying, I will mention one more, a Commander on half-pay, who stands on the list as (15), out of whose total of 1420, 181 only are due to mathematics. Now, as the limit for the College Certificate (the G of the Navy List) was fixed provisionally last year at 1200, it is quite clear that this Commander would have obtained that certificate, independently of his marks for mathematics, a subject to which—as a matter of fact within my own personal knowledge—he had, whilst at the College, paid little or no attention.

The course for the Gunnery Lieutenants is closely defined: it includes,—besides mathematics,—physics, fortification, and some part of military surveying. Other subjects are optional, though, as a general rule, they have not time for them. Of the Half-pay Officers I have referred to, (3) made his numbers in physics, chemistry, steam, international law, French, and German; (4) took up the same subjects, substituting marine surveying for German; and (15) amongst other subjects, obtained exceptionally high numbers in marine surveying and in French.

It is not by common report, nor by newspaper or magazine articles based on common report, that the work which we are doing is to be judged, when it can be brought to the exact measure of figures; and, as I have shown you, that of the numbers attainable in the final ex-

amination, considerably less than half are given for mathematics; that two Officers, taking a distinguished position in that examination, more than doubled the numbers which they obtained for mathematics; and that another carried off a certificate of merit without any mathematics at all; I think I have shown you also, that the outcry which has been raised about the excessive amount of mathematics studied at what is, you will remember, meant as and styled a strictly scientific College, is altogether unfounded. I may leave, then, this outcry to die of inanition; and having spoken at sufficient length of the necessity of mathematics, however elementary, as the basis of all scientific study, pass on to the discussion of other and more technical parts of our work.

Before doing so, however, as I have referred to the official report of the examination held at the end of the Session, I may with propriety speak of one cause which tends distinctly to keep down the average numbers obtained, and to show unfavourably the measure of our results. This is the very well known desire of the Officers on half-pay to get active employment; not only has that desire a continual unsettling influence, but the frequent gratification of it causes the division to be in a state of continual change. Officers get appointed to ships, and others are appointed to the College to fill up the vacancies. In this way many Officers who had made very satisfactory progress, some who would have taken a very distinguished place in the Class List, left us; and the new comers could seldom settle down to the work as well as if they had begun at the beginning of the Session. I think this is quite as it should be. It is of course disagreeable to the Instructors personally, and makes their work more onerous; but, on the other hand, it would be most prejudicial to the Service to have men pinned down to the class rooms, when there was employment for them afloat; and it would be most injurious to the College to have it supposed that it was in any way a hindrance to active employment. The alternation of students tells, of course, unfavourably on our lists, but so long as an Officer after, say, six months' study, carries away a fair equivalent as acquired knowledge, the advantage to the Service is gained, just as surely as if he remained for the examination and won a most brilliant G.

It is distinctly stated in the Admiralty Circular that "As regards Officers on half-pay, my Lords are particularly anxious that young Lieutenants should at once, on their promotion to that rank, avail themselves of the advantages of the College before their turn would come for appointment to a ship. The regulations specify allowances which are intended to remove any pecuniary difficulties in attending the College; and special consideration for appointments will be given to Lieutenants who thus occupy in so useful a manner the time necessarily spent on shore."

So far as the Lieutenants are concerned, this paragraph is being acted up to. Of the Lieutenants on half-pay now at the College, a very large proportion have been promoted within the last twelve months. There has been as yet little opportunity to see in what way the Admiralty will interpret their promise of "special consideration for appointments," and it would be evidently out of place for me to

speculate on their intentions; but, as a known fact, I may say that of the eight Lieutenants recently appointed for service with the Arctic Expedition, three were appointed actually from the College, and two others passed out from the College only eighteen months ago. If it is to be understood that these Officers owe their appointment in any way to the College, I think that their removal under such circumstances will give a far greater *impetus* to the cause of scientific instruction than even the additional G's which would, we may assume, have in due time appeared in the Navy List.

Returning then to our schedule. The study of physical science must be considered as to a great extent the experimental illustration of the truths of applied mathematics, and as the complement of mathematical study. We cannot suppose that any one will make extended progress in it unless he has a sufficient groundwork of mathematics; at any rate, I am quite sure that the mind whose powers have been strengthened and quickened by mathematical study will the better lay hold of and appreciate the grand physical laws. But even without any mathematical knowledge at all, the exposition and illustration of these laws must sweep away many pet forms of ignorance. Thus, for instance, a very favourite dogma amongst the uninstructed is that a man has a certain active power of suction. I assure you I am speaking within my own personal experience. I believe that comparatively few have had any real understanding of the principle of the barometer, or any capability of even attempting to understand its fluctuations. I believe—no, I am sure—that the laws of heat, light, and magnetism have been equally mysterious; while as to mechanics, I need but remind you of Mr. Reed's bitter remark, and the general though unpleasant feeling that there was a great deal of truth in it.

When we see the curious letters from Naval Officers that constantly appear in the daily or weekly papers, letters which betray—or, I should rather say, proudly display—an utter ignorance of the very first principles of mechanics or of hydrostatics, written by men who have grown grey amongst moving masses and displaced fluids; when we read the remarkable pamphlets which give too good grounds for sarcasm or sneer, what are we, who love and revere the Service, to do but to press most earnestly on our younger Officers the necessity of scientific study?

Chemistry is, perhaps, on a more independent footing than physics, simply so-called; it must, however, be regarded as a valuable auxiliary, and the two together have been rightly judged subjects most important to a Naval Officer, as bearing directly on the laws of equilibrium and motion, of heat, light, magnetism, electricity, and combustion, and as giving him an insight into the more modern appliances to move, or guide, or defend our own ships, or to destroy those of the enemy.

The importance to a Naval Officer of some knowledge of the steam-engine has long been admitted. Practically, of course, it can only be acquired by actual practice; but that practice will be rendered easier should it ever become necessary, by a previous acquaintance with its theoretical principles, with the physical laws on which it depends, and with the technical and detailed applications of these principles and laws.

I may here remind you of a case that actually occurred, of a Commanding Officer having to take charge of the engines; it was an exceptional case, no doubt; but it is for exceptional cases that a zealous and able Officer will wish to be exceptionally prepared. The case to which I refer was the homeward voyage of the "Fox," from the Arctic, in 1859, under Captain McClintock. The engineer and leading stoker had both died, and Captain McClintock himself did duty in the engine-room. I may add that Captain McClintock, to whose mechanical aptitude Arctic travel has been so deeply indebted, had many years before taken a very high class certificate, both in mathematics and in steam, at the Royal Naval College at Portsmouth.

I had intended to speak at some length on the subject of nautical surveying; but this has been so lately brought prominently before you by my friend the Superintendent of Charts, that I may advantageously condense what I had meant to say.¹ Of the work which there is for surveyors to do, and of the very meagre staff of surveyors to do it, Staff-Commander Hull has given you a correct, if unsatisfactory idea. As a practical surveyor, he has of course considered the subject more essentially from a practical point of view, and has urged the necessity, or rather the need of increased activity in this department of the public service. Such a map as he showed us the other night, is not flattering either to our geographical science, or to our reputation for maritime energy.

But whatever may be our own wishes or opinions, it is above all the duty of the College and of the whole staff of the College, to make the best of existing circumstances, and, so far as possible, to prepare for the future. If the economy or parsimony of the nation at large will not back up the desire of the Admiralty to carry on a more extended system of surveys; and if as the necessary result, our experienced surveyors, disappearing into the limbo of the retired list, become each year fewer and fewer, it is the more urgent on us to enable Officers to obtain as much insight into the mystery of the craft as can be learned without actual practice.

I have already spoken at such length of our mathematical course, that I am half afraid to mention the word mathematics again; but I cannot help myself. The principles of surveying are essentially mathematical, and the requirements of surveying gave rise—as the name teaches us—to the science of geometry. Surveying, then, is simply the application of geometrical problems, and, except on a very large scale, for the most part, as I have already said, of the problems of the first and third books of Euclid. As including the more exact methods of astronomy, it requires also a practical familiarity with the problems of spherical trigonometry, and with the different projections of the sphere. I know very well that there have been in time past many able surveyors whose theoretical knowledge of mathematics was extremely limited, and who by long practice and experience, earned by many blunders, gained a sort of instinctive acquaintance with easily demonstrable truths; but I would distinctly maintain that the energy and ability exercised in gaining this acquaintance were thrown away,

¹ The Unsurveyed World, 1874. By Staff-Commander Hull, R.N. *Vide* Journal, vol. xix, page 48, *et seq.*—Ed.

and that a timely devotion to theoretical study for six months would have more firmly and more accurately established it than the many years of labour and difficulty.

More practical knowledge, again, although perhaps sufficient for the ordinary work of a survey, has no power whatever to adopt new methods. As a special instance of what I mean, I may mention that very pretty and very practical application of one of the properties of the circle, now known as "the danger angle." This was introduced—if I am not mistaken—by Captain Shortland, one of the most capable, perhaps I should say *the* most capable mathematician in the Service. The "four point" method of measuring the distance of a shore or light is another purely mathematical innovation, which was certainly not hit off for the first time by any mere practical surveyor.

None the less, surveying must be considered as, to a great extent, a "handicraft." No amount of Euclid or trigonometry will, by itself, make a man a surveyor; he must learn also the ready use of the instruments,—the theodolite, the sextant, the compasses, the protractor, and the straight edge; until a man can observe an angle accurately, and protract it correctly, and that, as a matter of course, he cannot use the instruments. The work must be done quickly, neatly, and in a workmanlike manner. There are few, perhaps, who—given the observation—might not in a clumsy, left-handed way, and in the course of time, get it put on paper. That is not what we want. We want a cultivated judgment of the points to observe, a habit, an instinct almost, of observing accurately, and a straightforward certainty of interpreting these observations. Now all this we can and do teach at Greenwich, and we have convinced even that unsparing critic, the Superintendent of Charts, who acted last June as our examiner, that we teach it with very fair success, so much so, that out of 300 numbers awarded for the subject, one Officer obtained the whole 300, another 298, and altogether 11 obtained more than 250.

All this, of course, is not the "rose," but it has the charm of being very near it; and I am quite certain that when the good time, for which Staff-Commander Hull has expressed such longing, shall return, the Captains, Commanders, and Lieutenants wanted for surveying ships will be readily picked out of the annual dozen stamped in the Greenwich Mint.

Many of these will of course never have any opportunity of carrying their knowledge into practice, on any large scale; but the advantage to the Service in general, of having Officers who can correctly take and protract a round of angles; who can even correctly fix a position by cross bearings, and not note for the purpose—as I have known done—a pair of bearings diametrically opposite to each other; who can in time of war lay down the soundings with the least possible exposure, and in time of peace with the greatest possible accuracy—the advantage, I say, of having Officers so trained is inestimable; and if we succeed no farther than in impressing on them the use and intelligent practice of the danger angle, I believe that we shall have introduced a new element of safety into the ordinary course of navigation; if only in teaching them the real meaning of a chart, and in giving them a right appreciation and understanding of it, we shall have at any rate removed that dread

sense of mystery, which tells so heavily on the nerves of many Commanding Officers.

But do not suppose that I am saying that we can turn out finished surveyors; we do not pretend to do any such thing. We know, as well as others, that nothing but practice, hard, actual, long-continued practice, joined to natural aptitude and cultivated intelligence, can make a finished surveyor; but we know also, that an Officer who has gone through the careful and systematic training which we can give, has already overcome the first difficulties of practice, and is very far advanced towards overcoming the last.

Fortification and military surveying have been introduced, as part of the Gunnery Course, and for the benefit of the Marine Officers who are at the College. I have often heard it asked, What possible use can the study of fortification be to a Naval Officer? Surely, if at any time it may be his duty to attack fortifications, it is well that he should have some understanding of his possible enemy; but, not to trouble you with abstract speculations, I may say that within my own experience I have known Gunnery Officers called on to plan, to trace, and to superintend the construction of field-works for the defence of a position which was actually defended by those works for several months. I speak of the position which, under Sir Michael Seymour, we held at Canton during the autumn and winter of 1856. It was also in the same campaign, that after the capture of the Bogue Forts, the Gunnery Lieutenants of the squadron were directed to destroy them; and built as they were of very solid masses of concrete, it was a work that demanded not only the disciplined energy of the blue jacket, but the educated skill of the Officer.

Of International Law as a subject of study, it is almost needless for me to speak. That our Officers should know so much of the established rights and privileges of foreign ships in time of peace, and more especially of neutrals in time of war, as may enable them to steer clear of diplomatic embarrassments, is evidently a thing to be desired; and the course of lectures which has been delivered by the Right Honourable Montague Bernard was directed principally to that end. So far as these lectures have gone, they have pointed out what, under different circumstances, an Officer ought not to do, and what he incurs risk and special responsibility in doing; but there has been no attempt to point out what he ought to do, beyond such guidance as the elucidation of the authorised restrictions may imply. The object would appear to have been rather to buoy the channel than to take the helm; and in this I would say a judicious moderation has been exercised; for any attempt to control the decision of an Officer as to his positive action in time of emergency, would be certainly perilous, and, possibly, even disastrous.

As to foreign languages, the pertinence and necessity for their study has been admitted, I may say, by acclamation. There has even, I believe, been some feeling of dissatisfaction that more time has not been apportioned to it. It must be remembered that in learning any language, there is a great deal of downright dictionary work before the learner, which he must do by himself. So long as the Instructor

points out the grammatical difficulties and the peculiarities of construction, and by dictation or reading, conveys a correct idea of the pronunciation, it is nearly all that is possible; and if the exigencies of the College do cut the time with the Instructor rather short, there still remain the discretionary twelve hours per week, which may very well be devoted to the grammar and the dictionary.

But this time, you may say, has already been disposed of; it has been allotted to the independent study of mathematics, or of physics, or of chemistry. Very well then, the languages cannot be learned. A Naval Officer is only a man; a man, too, whose past life has not tended to quicken his studious faculties; he is not an Admirable Crichton, nor is it to be expected that in a Session of nine short months he is to become the embodiment of all human learning, the rival at once of Airy, Tyndall, and Max Müller. If during his residence at Greenwich he obtains a fair working mastery over any one new subject, or even obtains such an insight into it that he can afterwards continue the study unassisted, his time has been very well employed.

Of drawing it is unnecessary for me to say anything; but I may add to the subjects of which I have spoken and which appear in the scheme of the examination which I have placed before you, two others which have been included during the present Session, and will be duly represented in the next Examination. The one of these is Nautical Astronomy on a theoretical basis. This is of course distinctly a branch of mathematics, and will be considered as such, so far as the instruction is concerned; but it will, I understand, form a separate and optional subject for examination. The other is Nautical Meteorology, comprising the geographical distribution of barometric pressure, of prevailing winds and monsoons, of rains, calms, and storms, and with special reference to the law of cyclones.

This completes the present list. I am sorry to say so, for there is one subject which indeed is prominently named in the Admiralty Circular of 30th January, 1873, but which it has not yet been found advisable or practicable to introduce. The subject I mean is Naval History. Now it may be objected that history is not science, and that it cannot properly be included under the term "Scientific Instruction." From any such opinion I differ. Science is knowledge; accurate and exact knowledge, as distinguished from loose, vague, and empirical; and in this, the true sense of the word, history may be studied scientifically just as well as anything else. If the genesis of a plant or the habits of an insect are things worthy so to be studied, how much more are the words, and deeds, and destinies of our noblest and greatest men; and with a Navy such as ours, possessing such a history, it is a matter of very sad reproach that so few of our Officers are really well informed concerning it. I should be ashamed to guess at the very small percentage of Officers on the active list, who could correctly and intelligently discuss even the leading events of our annals; such say as the battles of Barfleur, or Quiberon Bay, or the First of June; Rodney's West Indian, or Sir Edward Hughes' East Indian campaign; Keppel's action off Ushant in 1778, or d'Orvilliers' cruise in the Channel in 1779.

A great deal has been said at different times about the study of tactics, but the scientific study of history is the study of tactics; it is a great deal more; it is the study of strategy, of organisation, and of discipline, and it is the only sound basis of that study. If it is admitted that these things can be studied, undoubtedly they can best be studied at the College, whose library, yet very imperfect, is backed up by the library of this Institution, and by the reading-room of the British Museum, both within easy reach.

But in speaking of tactics I am not speaking of manœuvres, evolutions, and signals; in speaking of discipline I am not speaking of seeing the defaulters at six bells: these are the means by which discipline is maintained, or by which tactics are realised, and cannot be studied except practically on board ship, and in an evolutionary squadron. In this sense the only effective instructor in the code of discipline is a taut Commanding Officer, the only real or possible professor of tactical evolutions is the Admiral commanding the Channel Fleet.

The division of Sub-Lieutenants is so closely connected with division B, not indeed by College course, but by the intrinsic necessity of the Service, that I pass on to it in natural sequence. At the present time, it consists of the following:—

Acting Lieutenant.....	1
Acting Sub-Lieutenants	80
Acting Navigating Sub-Lieutenants	12
Chaplains qualifying as Naval Instructors	2
	—
In all	95

The scheme for the examination of Sub-Lieutenants has, as I have already said, and as is very generally known, been recently modified. As now fixed by the Admiralty, it is printed *in extenso* in the "Navy List," and it is therefore unnecessary to speak of it in detail. The course appointed for the Sub-Lieutenants at the College, previous to their examination, extends over six months; and it has been very freely objected that it is simply impossible for a young man to get even a smattering of the different subjects in that time. It has been forgotten, or ignored, that the time allowed him to prepare for the examination is not six months, but six years, and dates from his first entry on board the "Britannia" as a naval cadet; that every one of the subjects has formed part of the course of instruction for a great many years, and has been, for several years past, included in the intermediate examinations, if not in the final one. It is illogical to raise a cry, such as has been raised, about the injustice and cruelty of requiring young Officers to pass, at their final examination, in subjects which they have, all along, been required to pass in at their intermediate examinations; and if some of those subjects have been, in a measure, habitually evaded, the fact only proves the necessity of the step, which has now been taken, of bringing the neglected subjects more prominently forward. It is of course admitted that the carrying out these modifications will call

for much care and judgment on the part of the examiners; but until it has been shown that the examiners do not exercise that care, or are wanting in that judgment, the outcry that has been raised in some of the newspapers is, to say the least, premature.

It is, however, with the course preparatory to this final examination, so far as it relates to the College, that we are now concerned. It must, then, be understood that this course is not meant as complete in itself; it is the finishing touch to that long course of instruction which, as I have said, commences when the young Officer enters on board the "Britannia." Nevertheless, it must be acknowledged that, in very many cases, the results of that previous instruction are most unsatisfactory, and the number of candidates who join the College quite unprepared for the examination before them is sadly too large. This makes the work at the College much more severe than it ought to be, or than it is, by the Admiralty, supposed to be; and though we may hope that, as the system comes into more thorough working, and extends throughout the Service, this extreme pressure will stop; it weighs at present most heavily, both on the candidates themselves, and on the Instructors doing duty with them.

This pressure is most felt in those subjects in which the candidates are expected to be already prepared, and which, from their nature, require a long and laborious grounding; they have thus to devote the greater part of their time to these subjects, to the necessary neglect of the other subjects, for the study of which the College offers great opportunities. I do not hesitate to say that the arrangements made for the prosecution of these studies are most liberal, and the pressure, which doubtless does exist in the mathematical class rooms, falls rather on the Instructors than on the Officers under instruction.

In direct connection with this part of my subject, it seems right that I should refer to a point which has been, perhaps rather bitterly, discussed for some time back; the importance, namely, of the work done by Naval Instructors afloat. Now, I will not say that the present system is a good one; certainly it is an expensive one, and involves a great waste of teaching power; but so long as very young midshipmen serve their time in sea-going ships, I do not see in what respect it can be amended; when, however, it is argued that the work with the Naval Instructor is not more than six or eight hours weekly, and it is implied that no results worth having can reasonably be expected from six or eight hours' work in the week, I would say very emphatically that the implication is not correct; that at schools on shore, schools that annually send up men to Cambridge to compete for scholarships, six or eight hours a-week is counted sufficient time to allow to mathematics, even for the advanced pupils; and that any boy of sixteen ought to be able with that amount of work, to make satisfactory progress; that many do so, I know from my own experience; that very many do not, I also know; and it is not difficult to find out the reason why they do not. The instruction on board the "Britannia," earnestly and laboriously given, results in *cram*, not in knowledge; the cadets, as they join the sea-going ships, are most frequently puffed up with conceit and ignorance; they do not even know enough to be sensible that

they know nothing. Their idea is that they have escaped from school, and whatever they may have been in the "Britannia," are at any rate Officers at last. The idea is most natural, and if only it could be fully carried out, would be most beneficial. They have passed what appears a very high, and is undoubtedly a very severe examination; they have, probably enough, been commended by one of the Lords of the Admiralty, and have received not only gorgeous prizes, but the coveted white patch. They ought to be so far advanced as to retain with ease what they have been taught. But they are not. Their course with the Naval Instructor is thus too frequently unsatisfactory; a disappointment in the beginning, a drudgery to the end.

Whether it is the purpose of the Admiralty to continue Naval Instructors in sea-going ships, I do not know. The recommendations of the Naval Cadets Committee seem clearly in favour of their being continued, fully accepting the conditions that six or eight hours a-week is as much time as a cadet or midshipman ought to, or can, give. But when youngsters, properly grounded, attend school rather to have their previous knowledge turned to account, and to be taught, with reference to it, the practical applications of theory, the time will no longer be an abomination and a weariness, but an intellectual pleasure, and I think that under such conditions the work of the Naval Instructor will bring forth very abundant fruit.

I come now to speak of Division A, which consists, you will remember, of engineer Officers, students of naval architecture, and private students, amongst whom are included Officers of foreign services selected by their respective governments. The following is a tabular statement of those at present included in this division:—

Chief Engineers	2
Engineers.....	8
First Class Assistant-Engineer.....	1
Second Class Assistant-Engineers....	24
Students of Naval Architecture	8
Private students	1
Foreign Officers and students.....	7

Being a total of 51

Of these, the Second Class Assistant-Engineers are sent up from the dockyards on the completion of their time as engineer students. The conditions for their entry by examination before the Civil Service Commissioners, you will find in the Circular of the 30th January, 1873, to which I have already so often referred, and which is in fact the Charter of the College. I must, however, ask your forgiveness if I quote one or two sentences from it.

"Engineer students will remain for six years at the dockyards for "practical training in the factories, the fitting and erecting shops, and "to receive instruction in iron ship-building. They will pass a portion of their time in the drawing office and at the dockyard "schools."

I may here remark that this time at the dockyard schools is limited to two afternoons and three evenings, that is to say eleven hours in the week, during the first four years of their service. During the last two years they do not attend school, except occasionally in the evening. I again quote from the Circular.

"All the engineer students will be examined, as to their theoretical and practical qualifications, on the completion of their time at the dockyards, and those found qualified will proceed to Greenwich as acting second-class assistant engineers.

"Those engineer students who fail to pass this examination will be allowed to remain one year longer at the dockyards, and then be re-examined, when, if they are unable to pass, they will cease to be eligible for the rank of naval engineer.

"Acting second-class assistant engineers will remain at Greenwich for one session for study. They will be examined on the completion of the session. Four acting second-class assistant engineers will be selected from those who take the highest place at the examination, to pass through a further course of scientific instruction.

"These four will be examined at the end of the second session, and one or more will, at the discretion of the Admiralty, be allowed to remain a third session, on the completion of which they will be sent to sea as second-class assistant engineers, and after one year's service at sea, they will be considered eligible to fill positions in the dockyards and at the Admiralty."

Now I have read to you these *excerpta* from the Admiralty Circular to show you how earnest is the desire to have thoroughly capable and scientifically instructed men, and these only, in the Service, as engineer Officers. The standard which we hope systematically to obtain, and which, as a matter of fact, we do obtain, is exceptionally high; in mathematics especially there is no department of the public service in which the standard even approaches that which is reached by our best men, a standard which—though not so general—is, in its special subjects, on a par with the high honour papers at Cambridge.¹ And it is not only in mathematical, or purely theoretical subjects, that this high standard is obtained. The examination includes also applied mechanics and strength of materials, theory of waves, theory of the steam-engine, physics, and chemistry. I would only add that though these advanced students of last year were transferred from South Kensington, we are led, by the promise of those who have entered under the new regulations, to believe that our future standard will rather exceed than fall short of this first essay.

The final examination for the students of naval architecture is, in its main features, the same as that for the engineers. The number of these admitted to the College is however small, and the selection is previously made in the dockyards. Three, so chosen by competitive examination, are sent up each year, and these remain the three years,

¹ Professor Lambert, the examiner of Division A, last June, tells me that, taking into account the different nature of the examination, he would consider the best of these men as equal to a place amongst the first ten Wranglers.

fellow-students of the engineers; the course of instruction differing only in some points of technical detail, which it would be tedious here to specify. According to the Circular, they "must join with their parents or guardians in a bond for the sum of £250 to serve under the Admiralty for seven years, if required, after the completion of their apprenticeship."

It is not too much to say that this regular supply of highly educated and scientific men to the ranks of naval architects must be attended with the happiest results, not only to the Royal Navy, but to the mercantile marine; for it is not to be supposed that, as they gain experience, they will remain contented in the subordinate positions to which their mere numbers will necessarily limit most of them, whilst serving under the Admiralty. If, for its own wants, the Royal Navy can permanently attach to itself those of exceptional ability, supported by a staff of highly-trained juniors recruited each year, the whole shipping interest of the country will be directly and incalculably benefited by the services of many for whom there is not adequate employment under the Crown. The welfare and strength of the Navy is so bound up with the general prosperity of our merchant shipping and with the safety of our sailors, that we may feel a very high degree of satisfaction at the prospects before us of the ship-building work of the country coming thus into the hands of scientific men; and it is not difficult to picture to ourselves the good time when appalling catastrophes, such as have so often during the last ten years spread dismay amongst our seamen and carried mourning to many a fireside, may be memories of a distant past.

I have thus endeavoured to set before you an account of the present state of Scientific Instruction in the Navy, and a perhaps speculative view of the future. I have described to you the organisation and working of the Royal Naval College, the obstacles which stand in our way, and the difficulties we have to contend with. Not the least of these is an unreasoning prejudice which would seem to have been called into being by the peculiar circumstances under which the College was opened, and to have been fostered by obscure newsmongers for their own ends. If what I have said this evening should help in any way to remove this prejudice, I shall have done the cause of education good service, for it is impossible to doubt that it has, in some way, tended to prevent senior Officers joining the College. When we compare the numbers of Captains and Commanders who used to crowd to the old College at Portsmouth, with the very small numbers who have joined us at Greenwich, where the accommodation in respect to comfort and convenience is far superior, the difference—even allowing for the present reduced state of the lists—is too noticeable not to force on us the conclusion that they are deterred by some feeling such as I have spoken of. The Admiralty Circular declares the College open to receive twenty-five Captains and Commanders; at the present time there are only seven.

As I have had occasion to mention the old College at Portsmouth, I will with your permission say, in conclusion, a few words relative to the

change which has been made. The writer in "Naval Science," to whom I have already referred, has said, "We have no hesitation in saying that the late Naval College at Portsmouth was calculated to do more real service to the Naval profession in its older members than its more ambitious successor at Greenwich is yet doing."

I must say that in this I do not agree with him. I had myself the honour of being attached to the College at Portsmouth for more than six years, and I know more intimately than any Officer now serving—more intimately perhaps than any man now living, with the exception of my esteemed friend Professor Main—what that College did do and could do; what it did not do, and could not do. You will certainly not hear a word from me in disparagement of the old College, considered as a seat of instruction, and not as a poky little building full of draughts and bad ventilation, and foul drains and sickening stench. The building I certainly disliked, and shudder at the memory of it; but of the College I have a most affectionate recollection. I think now, and always have thought, that Portsmouth possesses many advantages as a centre of naval science; and with adequate accommodation and an adequate expenditure I believe that the College at Portsmouth would have been in no respect inferior; but, as a matter of fact, there was not the accommodation which was ready to hand at Greenwich, and the Admiralty refused to sanction any increased expenditure. The estimates for the College at Portsmouth amounted to something like £6,500; at Greenwich they are about £35,000; and we must be working on a very false principle indeed, if we do not obtain results, not perhaps proportionate to the increased expenditure, but still very considerably increased. That, as far as the Senior Officers are concerned, seven Captains or Commanders at Greenwich are deriving as much advantage in the aggregate, as twenty-five did at Portsmouth, I am not prepared to maintain; and so long as Officers of these grades shun the College, it is not doing its wished-for maximum of work; but as far as they are individually concerned, I believe we get them to study for a greater number of hours—if only for this one reason, that the air of the class-rooms is fresh and wholesome, which certainly could not be predicated of the large study at Portsmouth.

The burgesses and tradesmen of Portsmouth felt that the departure of the College was a real pecuniary grievance, and a great deal of the nonsense which was talked about the change arose from this very disinterested source. They seemed to think that they had a vested interest in the College, and that the instruction of Naval Officers ought to be subservient to the advantage of their pockets. I will only refer to the rumour that was got up, that Portsmouth was to be punished for electing a Conservative Member; Greenwich was to be rewarded for having given a seat to the then Prime Minister. I cannot, of course, say that such ideas never entered the Prime Minister's head; but this I may say, that if they did, the very ungrateful borough of Greenwich has not appreciated them.

The CHAIRMAN: We shall be happy to hear any gentleman who may wish to offer remarks on the interesting paper which we have just heard.

Lieutenant BOWEN, R.N.: Professor Laughton has drawn attention to the subject

of naval tactics, and he seems to think, with a great many other naval Officers, that we are unable to study the subject at Greenwich, and that our studies on the subject should be confined to past history. Now I do not think that we can learn very much by studying the deeds of our ancestors. In the matter of tactics I fancy they made a great many blunders that we ought not to repeat, and their tactics are quite unsuited to the ships employed at present. Still I do not think the subject of tactics must necessarily be excluded from the subjects of the College. Perhaps I ought to say what I mean by tactics. Tactics, as I understand them, are not mere evolutions, but manœuvres on a field of battle, by which we endeavour to outwit and overcome an enemy. An enemy's formation is limited to a certain number of mathematical figures, and as we can consider every formation that it is possible for an enemy to get into, so we can consider the formations we ought to endeavour to adopt to outwit and overcome them.

Connected with this, there is another subject to which Professor Laughton alluded, viz., fortifications. The fortifications all over the world are at present being modified to suit the requirements of modern artillery. The Prussians are fortifying the harbours of Kehl and Wilhelmshaven, and preparing, I suppose, for something. It is quite possible we may never be called upon to attack those forts, but their calculations are made for somebody. Now we gunnery Lieutenants at the Naval College only study the subject of field fortifications; of the subject of permanent fortifications we profess to know nothing. I do think we ought to give some attention to it, in view of the preparations that are being made abroad, perhaps for our benefit.

Another subject mentioned was foreign languages. We cannot study much at the College the question of foreign languages; our time is too limited; and a foreign language is a subject that requires a lifetime. But when a midshipman is abroad, there are many stations where foreign languages can be studied, such as in the Mediterranean, India, and other places, where instruction can be obtained for a very little expense during the stay of the vessel. Midshipmen are not likely to expend their small pocket money in procuring a foreign instructor, but I do think the Captain of the ship might be authorised to expend a certain amount of money in providing a foreign instructor from the shore to teach foreign languages. That we should compare so unfavourably with foreign nations in this respect, is not creditable to a nation or a Navy such as ours.

Another subject to which Professor Laughton alluded, was the letters and pamphlets written by naval Officers, but he omitted to speak of the very remarkable language in which they are sometimes written. Now a midshipman on going to sea at 12 years of age drops the study of the English language entirely, and I suppose never looks at it again—at least very few do, and much valuable information is lost to the country and to the service generally from Officers being unable to put their opinions and the facts that they have acquired, into good readable English. From the very nature of an Officer's service in the Navy, he has opportunities of visiting places and of seeing things that other people have not, and I believe that were Officers instructed in their own language, much information would be gained to the country generally. It will be said there is not enough time to admit of a course of mathematics and a course of languages as well. But when the midshipman becomes a Sub-Lieutenant, why not go on as a Sub-Lieutenant? I am sure it only requires to be commenced, for Officers to avail themselves of it.

Then as to the question of mathematics for Gunnery-Lieutenants. During our time at College, we learn a certain amount of mathematics, but we feel, even if we should qualify as Gunnery-Lieutenants, that we compare unfavourably with artillery Officers in any discussion that may arise as to naval ordnance. Although we learn mathematics at College, we do not learn how to apply the knowledge we have acquired—I mean as far as expanding gases, strength of materials, metallurgy, gunpowder, chemistry, and other points are involved. Were the present course for Gunnery-Lieutenants extended for another nine months, as is the case for the advanced class of artillery at Woolwich, we might gain in the Service, what we have not at present, a class of practical artillery Officers able to hold their own in this Institution and in other places with the artillery Officers of the other branch of the Service. I do not know that there is any other subject to which I need allude. I

felt, however, so strongly upon the subject of naval tactics that I could not omit mentioning it.

Captain NEEDHAM, R.M.L.A. : I merely wish to correct a statement made by the last speaker, when he said that no instruction is given in permanent fortifications at the Royal Naval College. I think I am right in saying that two afternoons in the week are devoted to the subject, and I suppose it is quite open to any Lieutenant to attend those classes if he pleases.

Lieutenant BOWER : It would be done at the risk of losing mathematics.¹ He would have to give up a certain amount of mathematical instruction to do so, and that he cannot afford to do.

Mr. ECKERSLEY, Chief Engineer, R.N. : I was very glad to hear Mr. Laughton at the end of his paper make a remark differing somewhat from what he had said in the previous part. At first he stated—at least, so I inferred—that to this country the scientific education of engineers was of no moment, and afterwards he qualified it by stating that it was. Now, having served at sea some 20 years, I know this country has lost an immensity of money through her engineers not being thoroughly educated. The Admiralty have now struck a good, deep, and honest blow in educating those men who must be the right hand of the Captains and Commanders of our future navies. When I joined the Service, during the Russian war, the Admiralty sent round the country soliciting for engineers; they obtained them, but they were not well treated; and the records at the Admiralty would show hundreds of blunders simply caused by the non-education of those men. Since then, the engineers are educated both in pure and applied mathematics. I did not hear Mr. Laughton speak of a Professor joined with Professor Miller (the Professor of applied mathematics). In our future naval warfare there is no doubt that the turrets, the guns, and the very hull of the ship itself will become smashed, knocked about, or battered, and if these persons know well how to apply the theoretical knowledge which they have gained there, it will repay, I am sure, the money spent upon their education at Greenwich.

Rev. J. B. HARBORD : I should like to say a good word in favour of the "Britannia," for I think an impression might go abroad that a considerable amount of blame is attached to her : I ascribe the difficulties the naval instructors of the fleet have met with, not so much to the shortcomings of the training ship as to the mathematical and theoretical subjects which they were expected to give instruction in afloat, being wholly dropped out at the final examination for the rank of Lieutenant. All the Naval Instructors in the world cannot alter human nature, and as midshipmen were not examined in Euclid and algebra, no power on earth could force them to study these subjects. A few years ago the two great defects in naval educational arrangements were the short course in the "Britannia," and the fact of these subjects that I have alluded to, finding no place in the final examination. The consequence was, that the knowledge of the midshipmen varied inversely with the period elapsed since they had left the training ship. I have grounds for knowing that this is no longer the case. The extended period of study on board the "Britannia" has already borne its fruits in the knowledge there acquired being more sound, so as to form a solid basis for future improvement; and we have seen that all the subjects which are requisite for a solid foundation to a scientific education now find a place in the final examination. I am quite sure better results will follow in future—that the Sub-Lieutenants will enter the College far better prepared and more fitted to take advantage of the opportunities which Greenwich affords.

The CHAIRMAN : I think we can best close the proceedings by giving our thanks to Mr. Laughton for his very interesting lecture. I need only say we shall couple the word "instruction" better with the Royal Naval College of Greenwich than the word "science," which seems to set everybody's teeth on edge.

¹ My point is not that permanent fortification is not taught. I am aware that it is taught to Officers of the Royal Marine Artillery, but that it is not taught to gunnery Officers, or included in their course of study.—G.B.

LECTURE.

Friday, February 19th, 1875.

FIELD-MARSHAL H.R.H. the DUKE OF CAMBRIDGE, K.G.,
G.C.H., &c., &c., &c., &c., Commanding-in-Chief, President of the
Institution, in the Chair.

THE INTELLIGENCE DUTIES OF THE STAFF ABROAD AND AT HOME.

By Major C. B. BRACKENBURY, R.A., D.A.Q.M.G.

BEFORE entering upon the main subject of the lecture which the Council of this Institution has called upon me to deliver to-day, it appears necessary to define the meaning of the term "Intelligence duties of the Staff," and to show why attention to them has of late become especially necessary. That "Intelligence" is not used in the sense of quick understanding, but in that of information, is, I believe, sufficiently understood; but the character of the information is not yet entirely plain to all minds. For instance, letters occasionally arrive from anxious persons who desire to know why John Smith or Thomas Atkinson has ceased to write to his affectionate but afflicted relatives. To take no notice of such communications would be simple but cruel, and valuable time is spent in referring the questions to commanding officers, who alone can deal with them properly.

Again, a paragraph appeared a few weeks ago in a morning paper, speaking of a class having been formed at Woolwich by the Intelligence Branch, for the instruction of officers in reconnaissance duties. Really the Intelligence Branch must not be supposed to be in competition with the able departments for military education.

By the "Intelligence duties of the Staff" are to be understood:—

Firstly, the collection, sifting, and arrangement of all information required by Governments and military authorities to enable them to take such measures in peace as will insure the rapid commencement and vigorous prosecution of any war whether at home or abroad.

Secondly, the diffusion of necessary or useful military information through the army and the country during peace or war.

Now, in proportion to the advancement of civilization, the machinery of war becomes more complicated, more costly, and swifter in its work. The necessity for readiness becomes every day more absolute, while the means for obtaining the latest information grow with the growth of armies and with those helps to swift action, roads, railways, and telegraphs. Let us spare a moment to compare the wars of ancient and modern times.

Herodotus relates that Croesus, desiring to check the growing power of Persia, set about preparing for war. First of all, with laudable caution, he put no less than seven oracles in different places,

through a competitive examination, by asking them what he himself was doing on a certain day. Having selected the Pythian Apollo at Delphi and another, he offered as a propitiatory sacrifice three thousand victims, together with much gold and silver, on one flaming pile. Out of the metal so melted he made certain images, amongst them a lion of pure gold. These and other offerings he sent to the temples, and asked whether he might attack Persia, and, if so, whether he should seek the help of allies. Both oracles said that if he marched against Persia he would "overthrow a mighty empire," and they concurred in the practical advice that he should form alliances with the strongest States in Greece. Upon this he made presents to all the inhabitants of Delphi, and sent a third time to ask if his power would be perpetual. The answer was, yes, till a mule should reign over the Medes. Then he had to find out which were the most powerful States in Greece. Satisfied on this point, he sought their alliance, gained it, prepared an army, and at last marched—to his ruin. When he, a prisoner in the hands of Cyrus, sent to reproach the oracle which had lured him to his destruction, he was told that he had been in too great a hurry, for if he had further asked what empire it was that he would destroy, he might have learnt that it was his own. Such was the Intelligence Department consulted in the old days, and such the leisurely preparation for war.

As for the speed of carrying out a campaign in ancient times, we will take only take one instance also from Herodotus. Cyrus, advancing upon Babylon, came to a river. In crossing it, one of the sacred white horses was drowned. The enraged warrior swore that he would make the river so insignificant that women should be able to cross it without wetting their knees. He carried out his purpose by diverting the stream into 180 trenches, but he spent a whole summer in the operation. Fancy the Germans stopping to bully the Saar or Moselle in 1870, because the then King of Prussia had lost a favourite horse, or even a clergyman, in the passage.

In the middle ages war was a chronic disease, never ceasing, never entirely exhausting. There was no general staff, no maps nor statistics to be studied. Later on came the Thirty Years' War, slow and barbarous. An idle and oppressive soldiery lived luxuriously on the fruits of the people's industry, and were, in truth, little better than organized robbers. The Seven Years' War was more scientific, but still slow, and was rather a king's game than an international struggle.

The French Revolution produced enthusiastic soldiers and brilliant commanders, but it was reserved for Napoleon I to show what could be done by a man of genius, aided by a staff trained under his own eye. It was a grand achievement when, in 1805, he marched a large army from Boulogne to the Rhine in 26 days; but that army had been long in forming, and had been worked as an army for a considerable period. The same military genius arrived in Paris on the 19th March, 1815, found an army of 155,000 men ready to his hand, and by the 1st of June had raised it to 250,000 of whom 128,000 were on the Belgian frontier. The constitution of the French Army of Italy, in 1859, was commenced early in February, war was declared

on 23rd April, and, 37 days after, 104,000 French soldiers were collected on the river Po, with 12,000 more in Italy, but behind them. At no time did the French Army of Italy exceed 130,000 men and 432 guns, and this army bore but a small proportion to the force France was supposed to possess on paper. We see here, however, an extraordinary advance in the possible rapidity of making war. But what is this to 1866 and 1870? In 1866, Prussian armies, numbering 220,000 men were placed on the frontiers of Saxony and Silesia in a fortnight; and in 1870, Germany, taken by surprise, mobilized her enormous forces in nine days, and had on the French frontier in eight days more, about 400,000 fighting men and 1,200 guns. The labours of the German Staff have since been directed towards arriving at still greater rapidity; and it may be confidently expected that a future campaign would see the mobilization and concentration performed in a period shorter by some days. The French are aiming at the same mark, and it is no extravagant supposition to conceive the face of Europe signally changed within a month from the outbreak of another war. For, in future, not armies, but nations, will meet in the first shock of battle.

It is vain for us to quote the experience of Wellington's Peninsular campaigns or the Crimean war; for, in the former, there were no railways nor telegraphs, and, in the latter, Russia had none that were of any use to her. Now she has many, and they are all designed with a view to military requirements. Surely this extraordinary development of speed in making war, demands some further preparation than used to be sufficient. Surely it demands that we should watch more carefully, and prepare ourselves more assiduously than has been the custom heretofore.

Let it not be supposed that there is some occult means by which neglect in peace could be atoned for in war. If the required information be not ready, it cannot be suddenly obtained.

Mr. Kinglake quotes Lord Raglan's despatch to the Duke of Newcastle, announcing his and Marshal St. Arnaud's acquiescence in the wish of the Home Governments that the Crimea should be invaded. In the despatch the English General says, "The fact must not be concealed, that neither the English nor the French Admirals have been able to obtain any intelligence on which they can rely with respect to the army which the Russians may destine for operations in the field, or to the number of troops allotted for the defence of Sebastopol; and Marshal St. Arnaud and myself are equally deficient in information upon these all-important questions, and there would seem to be no chance of our acquiring it."

At the time when this despatch was written, the Prussian organization, presently to be described, had been in existence for nearly forty years.

Supposing it granted that previous knowledge and preparation are growing more and more necessary for success in war, let us see what sort of knowledge is required by any country; for instance, our own.

First of all we ought to know our resources in men, arms, horses, and money. We ought to know, exactly, what troops, reserve or other-

wise, must be retained at home for the defence of the country, and such troops should be always assigned to the places they are to occupy. They should be definitely organized, as they must be in war, for why should we leave such simple, but tedious questions, to a time when all our energies should be free? Next, we must know the military features of our own country, and have thought over them so much, and turned them over in our minds so often in connection with the disposable force, that there can be no difficulty in deciding upon the plan of the defence; no hurry or indecision at the last moment. Garrisons having already been told off to their places, the great bulk of the remaining troops will form a field army. Its strength, organization, and means of supply may all be arranged at leisure during peace; and, finally, we must know what expeditionary force is available for a counter-stroke against the enemy's territory.

This expeditionary force should be told off now in time of peace, so that nothing will remain to be done but the periodical substitution of regiments, as they relieve each other in the ordinary course. The force should be definitely organized on paper with all its material and transport. The railways or roads by which it will move to concentrate on the coast should be specified, and the exact number of trains or days marches should be settled. The amount of tonnage required for its sea transport should be calculated, and the character of the various ships decided while there is plenty of time to think the subject out quietly. Even the boats required for embarking and disembarking should not be forgotten, nor the means of supply for the first few days. In short, the Staff ought always to be prepared with a definite answer to the questions—"How many troops are available for a movement on such a country (perhaps to the assistance of one of the colonies), and how soon can they be landed at the point of disembarkation, ready to commence a campaign?" This is no more and no less than all continental nations are prepared to do. They call the work, so far, "Mobilization" and "Concentration."

Arrived on the enemy's territory, or our own colony which is to be defended—the commander of the expeditionary force should not be like a stranger in a forest, nor as our gallant comrades were when they arrived on the Gold Coast. The information required for the successful and economical prosecution of war is obtained with comparatively little difficulty during peace, and should be ready in a concentrated form when war breaks out. It is of exactly the same character as that needed at home for home defence; only we must have also knowledge of the enemy's preparations, and such information is obtained more easily by the invader than the invaded, because the invader chooses his own time. This is one great advantage of the offensive in war. Finally, the commander should have his plan of campaign in readiness, so that his first blows may be struck at once. All these preparations may be so made at leisure, in peace, as to await only the last touch according to circumstances when war is imminent. The Army should be well supplied with maps, and carefully compiled military handbooks of the country. In Prussia, Austria, France, the minor States of Germany, and, I believe, in almost all other European countries, the

work above sketched is done by the "General Staff," and I now proceed to describe how they do it.

PRUSSIA.

The Prussian "Great General Staff" is the first to engage our attention, both because it has existed almost in its present form since the beginning of the great peace, having been organized in 1816, and because those of other countries have been formed on its model though with slight modifications.

The principles on which its founders and successive chiefs have acted, are, that the Officers composing it must be the very cream of the Army in talent, conduct, education, and physical as well as mental power, and that all arms must be represented. There is an excellent school for the development of the higher qualifications of Officers called the War Academy, which is, in many respects, like our Staff College; but neither does it furnish the whole of the candidates for Staff employment, nor is the successful accomplishment of its course considered to give any claim whatever to appointment. It is true that some of the best scholars of the War Academy, are annually chosen to work under Count Moltke, but with them there are always other Officers recommended by Colonels of regiments. No pupil, leaving the War Academy, knows whether he will be one of the chosen. All return to their regiments, and those selected are afterwards summoned to Berlin, where, together with the Officers sent up from regiments by their Colonels, they are placed for a year under the immediate eye of Count Moltke, who tests their abilities by giving them tasks to perform such as are the usual work of the Great General Staff. After the year they all return to their regiments. A few months elapse and then the best of them receive the rank of Captain on the Staff, putting on Staff uniform for the first time. Some of them are allotted to the corps or divisions, others to the Great General Staff at Berlin. In all cases the chosen ones are employed on real Staff duties, and the greatest care is taken, in the case of all Staff Officers, *not to cloud their faculties by too much routine labour at the desk*. Such routine work as is necessary is performed by a class of Officers called Adjutants, who form a corps distinct from that of the Staff though recruited to a great extent from the Officers who have passed through the Staff course. Bear in mind, if you please, this question of Adjutants for office work. We shall meet with it again hereafter.

The Staff Captains, whether attached to the Great General Staff at Berlin, or to corps and divisions, are kept perpetually engaged either in surveying, reconnaissance, acquisition and arrangement of information, or in duties having direct reference to the conduct of troops in the field.

After four or five years of Staff service they return to regimental duty; and, later on, part of them only are selected as Majors on the Staff. These fortunate ones have, by this time, gained some seven or eight years' promotion above their regimental comrades. But there is little or no jealousy, for their tests have been severe, and everyone has confidence in Count Moltke.

Promotion to the rank of Lieutenant-Colonel and Colonel goes in the Staff, and the successful Staff Officer thus reaches the command of a regiment some years before he would have done so if he had remained what is, by a strange misnomer, sometimes called amongst us "at his duty." Surely a hardworking Staff Officer is as much "at his duty" as he is who has remained with his regiment. The latter has doubtless done his duty in his sphere of action. So has the former, and his sphere has been a wider one, his work more severe.

Thus it may be said that the only passport to the Prussian Staff is hard work, the only admitted claim to remain in it is that of approved power. The system has found such favour in the eyes of other nations that it is likely to be adopted with very little alteration by both France and Austria.

Having thus watched the accumulation of a large body of highly qualified Staff Officers, let us now see how they are employed in peace. The first great fact is that all their labours are directed to one end—preparation for war—and that so thoroughly that there is nothing left unprepared when the time of trial comes. Prussia, and therefore, Germany, can never be caught unawares. She is always and absolutely ready. It has been said that when war is declared, Count Moltke has only to touch a bell and the machine is set in motion. If for Count Moltke's name we substitute that of the War Minister, and for the bell a few telegraphic messages, the metaphor becomes a simple fact. Nor is there anything secret or incomprehensible about the means. The only wonder is that all nations did not know the fact and prepare themselves in like manner long ago. You know that each detail of mobilization is arranged beforehand so that the Army Corps are immediately raised to their war strength by their Commanders. The rest of the preparation is worked out by the Great General Staff at Berlin. What are its organization and action?

Great General Staff at Berlin.

At its head is Count Moltke, whose name will shine the brighter as history grows older. He and his subordinates have nothing to do with the War Office, except to supply it with any information it may require. Nor have they anything to do with the troops except the Railway battalion, a sort of nucleus for railway studies in peace. Of this battalion Count Moltke is Inspector. The celebrated chief and his band of workers occupy a magnificent palace lately built outside the Brandenburg Gate, at Berlin. Bearing in mind that Bavaria and other German States have similar establishments, it is not a little remarkable that Count Moltke has under his hand, exclusive of all Staff Officers doing duty with the troops; exclusive of Officers permanently employed on the survey of the country; exclusive also of the establishment of the Minister of War,—no less than from 91 to 101 trained Officers always at work on the studies considered necessary as preparation for war. The number is made up by 61 chiefs of sections, Field Officers and Captains actually on the Staff, and 30 to 40 Officers who have been trained at the War Academy or recommended by their Colonels. There are, besides, 115 employés such as

registrars, draughtsmen, printers, &c., but I think that, for the purposes of this lecture, we had better confine ourselves to the Officers.

The 61 Staff Officers belong to two classes:—

1st. The Active Staff liable to service with corps and divisions in their turn.

2nd. The *Neben Etat*, or accessory establishment, consisting of Officers noted for special scientific acquirements, who are content to relinquish the chances of distinction in the field for the solid advantage of permanent employment at Berlin.

During peace the Great General Staff is thus divided:—

Central Bureau, and

- A. The Three Sections.
- B. " Railway Section.
- C. " Section for Military History.
- D. " Geographical Statistical Section.
- E. " Topographical Section
- F. " Office of Land Triangulation } about to be amalgamated.
- G. " Intelligence Office.
- H. " The Map Room.

Central Bureau.

Count Moltke has two adjutants who, with a secretary and staff of clerks, conduct the whole of the correspondence of the Great General Staff. The first adjutant makes a daily report to his chief on the progress of business and has charge of all personal affairs.

A.—The Three Sections.

The business of the Three Sections is to collect from all available sources the latest information concerning European Armies, to follow all their changes in organization and to keep up to date systematized information concerning them. They are also bound to issue periodical descriptions of those armies for the use of the General Staff.

The First Section has charge of what is called the Eastern theatre of War, comprising Austria, Russia, Denmark, the Turkish Empire, Greece, Asia.

The Second Section has charge of the Central theatre of War, comprising Germany, Italy, Switzerland.

The Third Section has charge of the Western theatre of War, comprising France, Great Britain, Belgium, the Netherlands, Spain, Portugal and America.

Colonies go with the countries to which they belong.

You will observe that the Three Sections devote their attention especially to foreign armies.

B.—Railway Section.

Collects and arranges systematically all information on railways at home and abroad, especially with regard to their capacity for carrying troops. Upon this information the section works out:—

First. Instructions for the transport of troops and munitions of war.

Second. Plans for transport of the German forces under different suppositions so that the German Army may, in the event of war, be concentrated upon any point likely to be threatened, with the greatest possible speed.

Third. Examination of all projects for new railways.

A short railway line has lately been constructed near Berlin, with the avowed object of practising during peace the military use or destruction of railways during war. Different time tables are compiled by this section and kept up to date, so that, at the moment of war, there is not the slightest doubt as to the day or the hour when particular corps, or parts of corps will arrive at the destined point of concentration. But, like all German military institutions, the work of the Railway Section is so prepared as to be elastic. In 1870, the sudden declaration of war by the French led to the supposition that they would invade and occupy the Palatinate before the German Army could concentrate there. Subsequently the inaction of the French enabled some of the German troops to be carried on by the trains which had at first been ordered to halt on the hither side of the Rhine. The railway battalion is under this section.

C.—Section for Military History.

It is unnecessary to point out the practical value of the study of military history. Fully impressed with its importance, a section of the Great General Staff devotes itself to the accumulation and arrangement of historical records, and the preparation of excellent histories of great wars. The annals of Prussia have of late been so rich in materials that the Historical Section has been kept hard at work upon the wars of our own time.

D.—Geographical Statistical Section.

The duties of this section are to collect and arrange all information of military value bearing on the topography and statistics of foreign nations, as well as the statistics of Germany. It works in close connection with the Topographical Section, out of which it was developed a few years ago. As the Three Sections devote their attention to armies, so does the Geographical Statistical Section study all other matters of military value relating to foreign countries. The European powers are treated "exhaustively," and you know what exhaustively means when spoken by a German. Non-European nations, such as America and the British colonies, are treated in less detail, but all the principal facts concerning them are recorded. I have reason to know that attention has lately been paid to India. The section is also employed in correcting foreign maps and marking interesting details upon them. For this purpose it has a photographic establishment.

E and F.—Topographical and Land Triangulation.

These two sections are about to be amalgamated, as they carry out the same great work—the survey of the country—with special regard to military requirements. The Land Triangulation undertakes the most scientific part of the business, such as the cadastral survey. The Topographical Section works out the details and prepares the maps.

Being myself a gunner, I may perhaps be permitted to remark that the most scientific part of the survey is carried out by artillerymen,¹ who work under the guidance of the Great General Staff.

G.—*Intelligence Office.*

This remarkable institution was organized as a distinct permanent section of the General Staff in 1863, the year before the Danish War. All the information obtained by the other sections is handed over to it, systematically arranged and ready for use, so that it is, in peace, the one office which knows everything, and can answer all questions which Count Moltke may ask. It receives, besides, a considerable amount of secret intelligence even during peace. When we remember that service in the Army is universal in Prussia, and that a large proportion of the German merchants, clerks, and other employés working in other countries have been "one year volunteers," we cannot but be struck by the immense facility for gaining military information possessed by this highly organized and warlike nation.

At the outbreak of war, the principal Intelligence Office remains at Berlin, and uses all means of getting information. Officers, Police, the Diplomatic Corps, spies paid or otherwise, are employed, and money is freely spent for the one great end.

An Intelligence Office is also formed at the head-quarters of each Army and Corps, under the superintendence of the chief of the Staff, who details one of his Staff Officers for the special duty. These minor Intelligence Offices are all in communication with the chief office at Berlin, and thus any information, wherever reported, is, by means of the telegraph, made instantaneously useful to all.

H.—*The Map Room.*

In the Map Room are stored original surveys, and a quantity of maps for distribution. This section also registers all map work produced by the General Staff, and is in charge of the accounts and financial business generally.

Travels of Officers.

In the early part of each year the various chiefs of sections report to Count Moltke what points in the information under their respective charges require addition or elucidation. Acting on their reports, Count Moltke sends Officers to travel, giving them definite instructions as to the information required, and the day on which it must be furnished. All the reports find their way to the Intelligence Office.

The Staff Journeys, as they are called, form a great feature of the work. Under charge of Count Moltke, the Officers of the Great General Staff proceed once in the year to a particular district of the country where they act in all respects as the staff of an army engaged

¹ Oberfeuerwerker. I should be sorry if any mistake were made as to the meaning of this passage. In most continental countries, as in Prussia, the survey of the country is directed by Staff Officers, and it is an axiom that all arms are to be fairly represented on the General Staff. The Artillery *as such* is always a fighting corps.—C. B. B. 26/2/75.

day after day. They have to make reconnaissances and reports, to design manœuvres, issue orders to imaginary corps and divisions, select quarters or bivouacs, and generally perform all duties of the Staff in the field.

The members of the Great General Staff are available for work in any of the sections, as are also the young Officers attached, after their course at the War Academy, or sent up by the Colonels. Thus, at a critical period of their lives, the aspirants for staff employment are brought in contact with the leading military spirits of their country, and with the great master of modern war. The work of these young Officers consists of preparation of memoirs on geographical or statistical subjects, solution of strategical and tactical problems, descriptions of foreign armies, and historical essays. In fact, the information already acquired is placed at their disposal, to be dealt with by them as Staff Officers would have to deal with it. The best papers are laid before Count Moltke by the chiefs of sections, and some of them are published in the "*Militär Wochen Blatt*." Publication is considered to be one of the special duties of the Staff, and arrangements for the purpose are made with military publishers at Berlin. Thus a constant stream of information flows from the Great General Staff to the Army and the country.

When war is declared, the main part of the Great General Staff joins the Army, the Officers being used to form the Royal Head-quarter Staff and the Staff of Armies. They are used, in fact, wherever their services are likely to be most useful. Half the *Neben Etat* remains at Berlin, and keeps the machine from rusting, but the chief work of the Department is over, because that for which it was preparing has come.

Such is the organization of the Prussian establishment corresponding with the newly-formed Intelligence Branch in England. We will now pass to the Austrian.

AUSTRIA.

The whole of the Austrian Staff, whether at head-quarters or with the troops in districts, is considered available for Intelligence work, and is employed upon it. But the staff in districts, like our own, has much routine work to do, and there is now a strong cry heard from them for relief from this burden. They ask that it may be transferred, as in the Prussian service, to a separate body of Adjutants. In fact, though the terms may differ, they desire to approach a system in some respects not unlike our own. The duties of their Adjutants would be closely similar to those of our Adjutant-General's Department, and their General Staff would then correspond with our Quartermaster-General's Department, especially since the latter has now an Intelligence Branch.

Time would fail us to describe the changes and experiments which have been made in the organization of the Austrian Staff since 1866. Suffice it to say, that the authorities leapt at one bound from that dangerous institution, a closed Staff whose Officers did no regimental duty and never commanded troops, to one in which the Staff had no advantage at all in promotion, but rose exactly as regimental Officers

rose. The whole scheme is now undergoing revision, and it is almost certain that the Prussian and English principle, of insisting that Staff Officers shall take a turn of regimental duty, will be adopted, and to this will be added, in order to draw the best Officers to the Staff, the further Prussian principle that Staff Officers shall gain considerably in promotion, so that they may have a greater chance of high command in the field.

The Austrian Department corresponding with the Prussian Great General Staff dates, in its present form, from 1871, and is thus organized:—

- A. Directors' Division.
- B. Military Description of the Empire.
- C. Ditto ditto of Foreign Countries.
- D. Railway, Telegraph, Post, and Steam-boat Division.
- E. Military History Division.
- F. Statistics of Foreign Armies.

In these divisions are employed 68 permanent Officers, besides clerks and Half-pay Officers, whom the Chief of the Staff has permission to employ, bringing their pay up to full pay for the time of their employment.

In addition to these strictly intelligence divisions, there are two staff departments, much of whose work is of special use for purposes of information. They are the *Military Archives*, divided into three sections. 1. The Archives. 2. The Library. 3. The Topographical Department, and the *Military Geographical Institute*, which is charged with the survey of the country and the production of maps.

If we were to include the Officers employed in these two departments, the total would be raised from 68 to 154, but we will omit them, because much of their work is for general military, and even civil purposes, only let us remember that the staff can always count upon them.

A.—*Directors' Division*

Conducts the correspondence, acts as a registry, deals with personal questions, and staff regulations. It has always a certain number of extra Officers attached to it, employed in reading and making remarks upon reports which have been sent in. The Director is thus enabled to decide upon the qualifications of Officers employed on reconnaissances or kindred work.

B.—*Military Description of the Empire.*

C.—*Ditto ditto of Foreign Countries.*

These two divisions may be taken together, because they are likely to be amalgamated, and because the character of their work is the same.

Hitherto, "The Empire" and "Foreign Countries" have been divided, for purposes of study, in two different manners. The Empire into seven "Fields of operation," Foreign countries (in Europe) into four "Theatres of War." The same, or almost the same, system has been pursued in arranging the information regarding them; and the

result is a mass of printed matter highly valuable, but difficult to fit together.

It is now in contemplation to amalgamate the two divisions, and to co-ordinate the "Fields of Operation" and "Theatres of War," so that home and foreign territory may be treated as one for military purposes. This seems a practical idea, for it is certain that, when war is declared, frontiers disappear from purely military calculations, and are replaced by natural features of country which may be either within or without the political confines of the State.

The Austrian military description of country is most elaborate, and contains all that can possibly be wanted for the most exhaustive studies. The form in which it is kept is valuable for the office or the barrack-room, but some Officers complain that the books are not strictly pocket-books, and could not conveniently be carried in the field.

The information required for war is brought together and arranged on two different but allied principles, and printed in octavo.

- 1st. General description of theatres of war, giving the peculiarities of countries, their topography, wealth, inhabitants, politics, and even languages; affording, in fact, all the information required for making great strategical decisions.

- 2nd. Description of the routes along which armies will probably march. These give all the information required by troops in movement, and are the results of the logistical studies of the Austrian Staff. Detailed reports on fortresses or strategical points are added, together with a topographical and statistical summary.

To gather this information, all available means must be used. For instance, in Austria all Government Departments receiving intelligence which bears on the military strength or resources of other nations are bound to send it at once to the Minister of War for the use of the Staff. Thus from one Minister, the Staff hears of the development of a mercantile marine, or the opening of a new port, from another, of the growth of some important industry.

Almost the whole of Europe has been thus studied, and the works are printed for use in time of war. There are distinct books for the two different "descriptions."

Corresponding with the books mentioned above are two sets of maps—Operation Maps and Route Maps.

The Operation Maps are produced by photographing the standard maps, and printing them very pale. This faint delineation of country is then worked over by hand, the useful features being accentuated and the rest left indistinct. They illustrate the first set of books.

The Road maps are prepared on a large scale, and then reduced. A small photographic copy is contained in each volume of the "Route Description" books. From these maps are removed all features not bearing upon the science of marches. Roads, railways, bridges, camping grounds, &c., are specially marked. *The roads all over Europe are divided into day's marches, each of which has a number, and*

corresponds with a certain page of the "*Route Description*," where is to be found, under the same number, a military description of the road and neighbouring positions.

All the maps and descriptions are kept up to date—those referring to the Empire by the Staff of Generals in districts, those embracing foreign countries by the Head-quarters Staff, partly from material collected by the various "Divisions" of the Staff, partly from the reports of Officers who are constantly travelling to collect and verify information.

The 2nd and 3rd Divisions have published a number of works which take a high place among military standard literature.

D.—Railway, Telegraph, Post and Steamboat Division.

Precisely similar in the character of its work to the Prussian Railway Section but, as is shown by its title, its studies have a more extended scope.

E.—Military History.

Similar to the Prussian Historical Section. It has produced some works of the highest value for military students.

F.—Statistics of Foreign Armies.

This division has to collect and classify information relating to foreign armies, and further, to diffuse such information as widely as possible throughout the Austrian Army.

Newspapers and other periodicals are daily read through and marked, so as to call the attention of the other divisions and departments in the War Office, through which the papers circulate, to any paragraphs specially interesting to them.

Cuttings are made from the papers and pasted in books, together with manuscript notes from reports of Military Attachés, &c., on the same subjects. Thus, if the latest information on any subject of more than average interest is required, it is ready to hand at once. The work of this division is excellent.

Maps of foreign countries are kept with the territorial districts marked upon them, and states giving the actual strength of the armies kept up to date are attached to the maps.

From these states and from other information the division compiles a work,¹ the title of which may be translated as "*Comparative estimate of the War Strength of European Powers, by Land and Sea.*" It is not confidential, and is sold in Vienna for about eighteenpence. Other works on foreign armies have been compiled in the division.

FRANCE.

France, the latest country which has had to confess the necessity for reorganising its military institutions, is bringing her staff system under review and making great and radical changes.

¹ "Vergleichende Darstellung der Wehrverhältnisse in Europa zu Land und zur See." 1874.

Up to 1869 the French Staff was a closed corps, fed by the Staff School. After leaving the school, the officers had to spend five years doing regimental duty with the different arms of the service; but when this service was completed, and they were actually appointed to the Staff, no further regimental duty was required from them. Hence arose an absence of knowledge of drills, discipline and interior economy, which was said to affect seriously the efficiency of the *Etat Major*. Colonel Stoffel speaks sarcastically of Staff Officers whose time had been so spent in clerical labour that they were unfit to appear before troops, and were even, sometimes, unable to ride!

In 1859, an Imperial Decree of 19th July, placed the competition for the Staff after, instead of before, entrance into the Staff School, and admitted to the hope of future Staff employment a number of officers in excess of those required to fill the Staff Corps. These extra officers were to be called "*Adjoints d'Etat Major*," to serve ordinarily with their regiments, and to be called to fill up the Staff in case of war.

This was a step towards throwing the Staff more open; but in the opinion of most of the best Officers in France, even of those now on the Staff, the measure did not go far enough.

Last month (January 1875), a final change was made. A new school called the "*Superior War School*" was instituted for Officers who have been some years in the service. But, as in Prussia, only the best pupils will receive commissions as Captains on the Staff. They are to do duty for two years with the arms other than that from which they originally came, then serve two years on the Staff in districts; and, finally, two years with the head-quarter Staff in Paris. Their promotion is afterwards to go in the Staff, but they must do regimental duty for a time in each grade.

Commanders of army corps and divisions will have, besides their regular Staff Officers, certain other assistants called *Officiers d'Ordonnance* who will, if I am not mistaken, perform the same duties as those of the Prussian Adjutants or our own Adjutant-General's Department.

This is as close an approach to the Prussian system as French national habits admit of. The principles are the same, but there is no slavish copy.

Let us now examine the organization of the French departments of the Staff at head-quarters charged with intelligence or information duties. They are specially interesting, as they are not older than our own Intelligence Branch.

A decree of the President of the French Republic, dated 12th March, 1874, organised the department of the Chief of the General Staff as follows:—

"The department of the Chief of the General Ministerial Staff
"comprises the Ministerial Cabinet and Six Bureaux, namely:—

"1st Bureau. General organization and mobilization of the Army,
"States and Effectives.

"2nd Bureau. Military Statistics: Historical Office.

- " 3rd Bureau. Military Operations; Instruction of the Army; Topographical Office.
- " 4th Bureau. Etappen and Railway Service; Execution of Movements of Troops; Transport of Troops by Land or Sea.
- " 5th Bureau. General Correspondence.
- " 6th Bureau (or War Dépôt).—Technical Services; Collections; " Material and Accounts of the General Staff."

Since then experience has suggested several modifications.

The 5th Bureau has been absorbed by the 1st; the distribution of work has been rearranged; and certain changes have been made in the number and duties of the officers employed. Further changes may yet be made; but the present organization represents the result of French experience up to this time, combined with their study of foreign systems, and cannot but be interesting and useful to us who are advancing in the same direction.

All the bureaux are now working hard on exactly the same principles as those adopted at Berlin and Vienna. But their method of carrying out those principles is specially interesting to us because their work, like our own, is yet in its infancy. All arms are represented among the Officers in the bureaux, the same studies as those already described are being carried out and, in addition, they have to work earnestly and steadily upon the numerous arrangements involved in the reconstitution of an army upon new principles. Time and much labour are yet required, but we may be certain that, after her task is completed and the machine properly put together, the power of France for war will be tremendous. Talent has never been wanting to her Officers.

The present organization, which may and probably will be slightly modified when the new military system is in full work, may be set down as follows:—

- A. 1st Bureau. General Organization and Mobilization of the Army. States and Effectives. Distribution of Troops. Correspondence.
- B. 2nd Bureau. All information regarding foreign Armies and Navies.
- C. 3rd Bureau. Military Topography and Statistics. Preparation of Military Operations. Instruction of the Army as a whole—such as Regulations for Service in the Field, &c. Travels of Staff Officers. Grand Manœuvres. Historical.
- D. 4th Bureau. Study of Railways. Execution of Movements of Troops. Lines of Communication.
- E. 5th Bureau (or War Dépôt). Drawing, engraving and altering Maps. Charge of Maps, Books, and Instruments.

Besides the Chief of the Staff and his aids, the number of Officers permanently employed amounts to 69. They are taken from all arms as well as from the Staff, in order to have specialists to deal with questions as they arise. But, besides the permanent establishments of

the Bureaux, Officers doing duty with their Corps throughout the country, whether on the Staff or not, are called upon to give their services in aid of the Staff studies at Head-quarters. For, indeed, the labour of seeking out the knowledge required is very great, and demands both much time and many hands. The work is being done for the safety of the country and no man can refuse his aid according to his powers. The adoption of this principle gives the Staff the assistance of an immense number of workers, whose labour is at once a benefit to France and an education for themselves.

1ST BUREAU

Is divided into three sections each under a Staff Officer:—

1st Section.—Organization of the active Army; its Distribution; General States; Effectives.

2nd Section.—Organization of the Territorial Army.

3rd Section.—Mobilization.

Little need be said of the work of this Bureau, though the importance of it is great at a moment when Organization and Mobilization are the most stirring military questions. But, consider the power and certainty such help as that of the talented Officers employed, gives to the military authorities during Parliamentary discussions. In fact, the law on the cadres has just now been settled by mutual agreement, although a severe conflict on the question was supposed to be impending, and everybody is satisfied. Is not this better than our plan of Royal Commissions and Parliamentary Committees succeeding each other in a weary series, the members approaching the subject with only one certainty,—that it is perfectly new to them and they must learn its rudiments?

2ND BUREAU.

Foreign Armies and Navies.

Twenty-four Officers are employed in this Bureau alone, and the number is found insufficient.

The studies are precisely similar to those of the Prussian "Three Sections," and the Austrian Section for "Statistics of Foreign Armies." Great Powers are studied separately, small ones in groups. The studies comprise, military institutions, organization, instruction, men, material, establishments. Naval affairs are treated generally in less detail than the land services.

All this information must not only be in the possession of the Bureau, but must be so arranged and co-ordinated as to be at disposal for the immediate enlightenment of the Government or authorities interested.

Moreover, to the 2nd Bureau is confided the task of spreading such information as may be desirable among the Officers and men of the Army generally.

This duty is performed by periodical or special publications, such, for instance, as the "*Revue Militaire de l'Etranger*." The French Government and military authorities have accepted the truth that it is

not enough to have information accumulated at head-quarters, but that it is wise to diffuse a knowledge of foreign military systems as widely as possible. Every encouragement is given to officers to study such subjects, and to travel for the purpose.

This Bureau receives and deals with the reports of the military attachés, and is responsible for bringing any valuable information contained in them to the notice of the authorities specially interested in it. By this course every head of a department knows that nothing interesting will escape him, while he is not burdened with the task of reading a mass of MS. which does not concern him.

The military attachés of French embassies, like those of Prussia and Austria, report directly to the Minister of War or the Chief of the Staff. In any case the Staff receives and deals with the despatches at once. English military attachés report to the ambassadors. Their despatches go to the Foreign Office, and thence through many hands before they reach the Intelligence Branch. Is not this system rather unpractical?

Before the late war, and its remarkable lessons, the French system was highly unpractical. Not only Colonel Stoffel's despatches, but the reports of numerous Officers sent to travel in Germany, called attention in the strongest terms to the superiority of the German organization for war, and to the extraordinary development of the military art in the country of Frederick the Great. Nay more, the inferiority of the French system was frequently insisted on. The reports were received, docketed, and carefully pigeon-holed in the War Dépôt, but, from the want of a department responsible for utilizing the information contained in them, those important documents were suffered to lie unread and unknown by the great officials in whose hands had been placed the safety and honour of the French nation.

The lesson has been a severe one, and the result is that at the present moment the chief anxiety is not to hide, but to diffuse information as widely as possible. Not only does the 2nd Bureau publish its papers, but Government money has been granted for the encouragement of the "Réunion des Officiers," an institution first established by private members, but now recognized as a means of bringing to the light of day, opinions, often crude enough, held by individuals concerning home or foreign military affairs. The publications of the Réunion are sometimes valuable to the authorities, always a safety valve for that intellectual energy so characteristic of the French. Thus a former source of bitterness and grumbling against authority has been turned into a well spring of information and contentment.

3RD BUREAU.

This Bureau is at present one of the most important and active in France, though many of its functions are of a temporary character, and will cease when the epoch of change ceases, when the Army is fairly reorganized, and the studies which must precede modern campaigns are completed so far as only to need periodical revision.

It is divided into four sections—

1st Section.

Preparation of Military Operations.—Study of probable theatres of operations at home and abroad. Travels of the Staff Officers. Grand manœuvres.

2nd Section.

Instruction of the Army as a whole.—Questions relating to general instruction of the Army. Preparations of rules applicable to all arms—*e.g.*, regulations for service in the field.

3rd Section.

Study and Arrangement of Documents necessary for Armies taking the Field.—Such as maps, statistics, military topography.

4th Section.

Histories.—Assembly of historical documents relative to the last campaign. Study of these documents with the object of extracting useful information from them, especially the modifications which should be introduced into the tactics of the different arms.

Think for a moment what this Office has to do. No less than to plan the defence of the country and the best means of attacking other countries. The same studies are pursued by Prussia, Austria, and other Powers. Surely we had better keep our eyes open to this fact. Now, strategical studies such as these, must be based upon accurate and detailed knowledge, or they will not be worth the paper they are written upon. To gather the accurate details, all the army is at work. No less than 80 Officers of the garrison of Paris have been occupied in studying the surrounding country with a view to the thoroughly scientific defence of the place. Let me earnestly beg you to turn over in your minds this necessity for employing Officers outside any new Intelligence Department. Without such aid, facts must be wanting, and all calculations must be baseless and delusive. Whoever has good will and common sense can assist in some part of the work. Neither are great talents required nor high education, but the work in itself is full of interest and instruction.

Officers belonging to the 3rd Bureau attend Autumn Manœuvres, and report on various interesting points for the information of their chief.

4TH BUREAU.

Railway Service and Movements of Troops. Lines of Communications.

Divided into two Sections.

1st Section, Railway Service.

Duties.—Work indicated by the "Superior Committee on Railways." (explained hereafter). Studies relative to the execution of this work. Relation with the railway companies.

2nd Section.

Execution of the Movements of Troops.—Sending the detailed orders required to carry out Ministerial decisions. Correspondence relative to all the movements of troops at home, and to or within Africa.

In November, 1872, a Committee was appointed to consider the whole question of railway transport and lines of communication. Its Report was adopted last July, and is now the basis for the work of the 4th Bureau. The scheme recommended and adopted is most interesting and instructive. The Report has been translated for the Intelligence Branch and would be published at once but for that terrible bugbear, the cost of printing.

There is no time to enter here into the details of the Report. Suffice it to say that all sorts of contingences in war and peace are provided for, even flying trains to be always kept packed full of provisions not far in the rear of operating armies.

The great principle is to combine the labours of Staff Officers who know what is wanted, with that of railway officials who know how best to supply the thing required.

France is divided into six great railway systems, each of which is placed under a Staff Officer who is called the "*Commissaire d'Etude*" for the line and its tributaries. Attached to him is a "superior agent," and the two form a committee with very definite duties and powers. They have to carry out the instructions contained in the Report, and they have legal power to do so. Provision is made for experiments and for practice of the troops. The Report can be bought in Paris, and is well worth reading, even by those whose duties are not likely to place them in charge of railways or lines of communication.

5TH BUREAU (*War Dépôt*).

The War Dépôt is chiefly concerned with the care of maps, books, and instruments, and with alterations to be made in the maps and statistics of the country.

It employs 16 Officers, 12 of whom are on the Staff, and a number of other employés.

GENERAL REMARKS.

If we now look back for a moment on the ground we have passed over, we shall see that the strictly Intelligence Duties of the Staff in Prussia, Austria, and France are directed and performed by Staff Officers devoted to that particular work, aided by the whole of the Staff of corps, divisions, and brigades, and, in France, where the work has hitherto been more or less neglected, by all the available talent of the Army.

We see further a general agreement as to the facts which ought to be known, and the manner of getting at the information. The work required may be shortly stated as follows:—

1st. A thorough military acquaintance with the topography and re-

sources of all lands belonging to the nation and its neighbourhood.

- 2nd. An intimate acquaintance with the armies and military institutions of foreign powers as well of the home army and institutions.
- 3rd. A scheme for movement of troops by railway, road, or water, according to probable eventualities. This is based on a study of home and foreign means of communication.
- 4th. Military history, which is always a mine of information if honestly drawn up according to official knowledge.
- 5th. Selections from the above items of knowledge carefully drawn up and published for the information of the Army. This requires frequent use of the printing press.
- 6th. In the three countries the Staff is charged with the issue of the requisite maps in case of war; and, for this purpose, is in close intimacy with the great map-making establishments represented by our Ordnance Survey, which is a civil branch, though conducted by Officers of the Royal Engineers.

This kind of preparation for war is considered quite as necessary as the provision of arms or the drilling of men. It ensures the absence of delay and confusion—those sure fore-runners of defeat—at the beginning of a war, and enables the nation to make the best of its resources whether they are large or small. A military power neglecting these Staff duties in peace may as well put its neck under the feet of its enemies. A portion of the Staff must be set apart for intelligence duties during peace by any nation which does not desire to be utterly confounded when overtaken by war. But it now becomes necessary to anticipate an objection sure to be made by those persons whose minds are under the dominion of fashion. They will recognise the value of such studies for foreign nations, but deny that England has any need of them. Or they will say, as has been said to me more than once, that an Intelligence Branch of the Staff is only ~~needed~~ ^{useful} on the supposition that England is likely to enter into a Continental struggle.

Let us for a moment, and for the sake of argument, grant that we are no longer a Great European Power, that we have no duties which may force us to draw the sword for a principle involving our own general interest, and that our name as a nation may be effaced from the books wherein are reckoned up by the remaining Great Powers, the forces they may have to deal with if they declare war. At least there remain upon our hands certain territories, not so very limited in extent, called the British colonies.

The colonies spend upward of half a million annually on their militia or volunteers; and have, not counting India, about 70,000 men ready for fighting, to say nothing of the legal powers possessed by the Canadian Government of calling out all the able-bodied men in the country, about 740,000.

To this the objectors will reply—"Oh! but we don't want to keep the colonies. We should be stronger if they were cut loose from us, and we

should trade with them all the same." Now, Gentlemen, we soldiers have no business with politics. If an English Government should ever, in the name of Her Gracious Majesty, cast the colonies adrift, our business will be loyally and humbly to carry out the orders we may receive. But we have every right to state plainly the military arguments for retaining a footing where we have it, that is, wherever the sun shines. Let me state the argument in its skeleton form.

Such a trade as that of Great Britain is based upon the safety of our merchant ships.

The safety of merchant ships depends upon their protection by a fleet of war-ships.

War-ships depend-upon coal, ammunition, and provisions, which are, none of them, found among the waves, but in depôts on shore.

Therefore the security of our world-wide trade obliges us to keep territory all over the world, for the supply of our Navy.

If this argument be of any value at all, it proves that no nation can, in modern times, keep the command of the sea without colonies, and, that command failing, England's fair palace of commerce would vanish like a dream before the first rude shock of war.

Whatever may be the ultimate fate of the colonies, there are no present signs of their leaving us; and, meanwhile, we surely ought to know something about them from a military point of view. We ought to study them at least generally, if not "exhaustively," as the Germans say. We are trying to do so now, and the attempt shows more plainly, day by day, how much we do not know and need to know. Yet, short as is the time since we began to work on the colonies, and few as are the workers, our labours have already borne some fruit. Foreseeing that Natal might become interesting from a military point of view, we prepared a *précis* of all information to be found in this country with regard to the colony Sir Garnet Wolseley has been suddenly ordered to go out to. Our *précis* was placed in the hands of the printers to-day, and when Sir Garnet starts on Monday next, he and each of the Officers of his staff will have in their hands an octavo volume of some 90 or 100 pages, containing systematized information on all the subjects likely to be valuable to him, from the history, geography, and statistics of the colony, down to such small details as the money, weights and measures in use, not forgetting the nature of the native races with whom he may possibly have to deal. Then our own home islands, Great Britain and Ireland, are by no means completely studied as yet, and all men will grant that we ought to be thoroughly informed as to the measures necessary for home defence.

The attitude of certain Englishmen, ultra-peaceable in talk, reminds me of that immortal member of the Society of Friends who once found himself on board a ship about to be attacked by an enemy. The Captain, needing every stout arm he could find, appealed to him to lend a hand in the defence. But no! "his principles would not allow him to fight." The enemy closed, and began to board. The Quaker shook his head, and, advancing to the bulwarks, pitched one of the assailments into the sea, exclaiming "Friend, thou hast no business here." I fancy that any nation which should aim at stripping England of

her colonial possessions, invading our soil, or taking from us the command of the sea, would soon hear from our most peaceable mouths "Friend, thou hast no business here."

But may we not go a step farther, and ask whether it is so absolutely certain that our swords will never again flash in the brighter rays of a continental sun? Never for the sake of conquest or from lust of territory. Such ideas are altogether dead in our minds. It is, however conceivable (to say the least of it), that we may be called upon to interfere in defence of a principle necessary to our national life. For after all, "Man doth not live by bread alone." A foreign writer has lately said, "scratch the British morality and you find a savage underneath." Let us rather say, "scratch the crust of British conventional talk and you find as bold and adventurous a spirit as ever moved our forefathers to the great deeds on the memory of which we feed our children."

Do you remember that the cry for perpetual peace was far stronger before the Crimean War than it is now? At that time public consent had gone so far that an ill-advised person could write a pamphlet proposing that, if England were invaded, we should receive our guests with open arms and win them by tenderness to offer us an indemnity instead of exacting one. Since then, we do not seem to have come much nearer the Millennium, and may fairly say—"scratch civilization and you find men and women with all their hopes and fears, pride and passion." But there is no need for argument. Mr. Disraeli in his place in the House of Commons, Mr. Gladstone in his late writings, and that great exponent of public educated opinion, the *Times*, have lately told us that England can no longer count on exemption from the common lot of mankind and of nations, a struggle for life, and, let me add, gentlemen—the survival of the fittest. Should such a struggle be forced upon us the country will turn to its soldiers and ask—"Are you ready?"

That time will not find us vying with other nations in the ostentation of our armaments, but it ought to find us knowing at least exactly what we can or cannot do. An army of 100,000 British troops kept up as it might be from home, is a force by no means to be despised. In 1871 it would have raised the siege of Paris, or crushed Faidherbe or Chanzy according as we had taken one side or the other. Such an army must, however, be ready to act at any moment or half its value is gone. When the time for action comes it will be too late to commence our studies of the means of moving our force or keeping it in the field. All that should be done now, when such studies would be a menace to nobody, not hereafter when the undertaking would be one of the signs of "drifting into war."

There is another important reason for the formation of such a department of the staff. General Todleben remarks, in his book on the defence of Sebastopol, that England has in peace no proper "service of the Quartermaster-General," and he adds, "All this so important part of the military administration is only constituted at the very moment when the troops take the field; thus, much time passes before the staff of the army can be completely organized." The

criticism is just, and still applicable to us. We have our classes and examinations for the staff at the Staff College, and, having got our officers, we scarcely ever again set them to do real staff work till war comes. Were it only for this reason the staff organization which I have just described as existing in foreign countries, would be of equal value in our own.

Theoretically, such work has always formed a part of the duties of the Quartermaster-General's Department, but practically, the few officers he has, are absorbed in office duties, so that he has had none to spare for geographical, statistical, and historical studies, or for calculation of strategical and tactical probabilities, based upon a known system of moving troops in war.

It is a significant fact that the proportion of Staff Officers to regimental Officers in the English army is less than that existing in Prussia, Austria and France.

In Prussia the proportion is	2·06
Austria	2·06
France	2·36
England	1·85

This state of things exists because the public mind does not understand what is the proper employment of staff officers, and, therefore, cuts the staff down as closely as possible. The popular idea is that the staff have to carry messages in the field, and be agreeable to their partners at balls, instead of being as they should be, an Argus-eyed and Hydra-headed giant, ever providing the information on which a General must needs base his plans, and working out the details necessary to give effect to his orders.

Then there is that terrible word of power before which we all tremble,—the Estimates. Let us make a little estimate of our own. At this moment, it is estimated that Europe could put something like ten millions of men under arms. Everywhere arsenals and dockyards resound with the clang of hammers. We ourselves are driving a roaring trade in war ships and arms. It is impossible to believe that an English Parliament will grudge the trifling sum necessary to keep us informed of the position in which we stand, and of the means necessary to keep us secure. It would be as if a rich man of indifferent eyesight, knowing that he would shortly be placed in the presence of savage animals, should grudge the money to buy a pair of spectacles. Nor should we forget that the work to be done is not in proportion to the strength of an army, but to the extent of territory, the number of souls to be defended and the wealth to be secured.

Turn your eyes towards this table, and say whether we have much or little to do in comparison with other European nations.

In round numbers :—

Germany ..	has 212,000 square miles of territory and	41,000,000 of people.
Austro-Hungary	" 240,000 " " "	36,000,000 "
France with	" 926,000 " " "	43,000,000 "
Colonies ..		
* Great Britain and Colonies }	" 5,400,000 " "	290,000,000 "

* Not including the Hudson's Bay Territory.

To achieve the work necessary for the study of all this country, and the military statistics of this huge population, we have now, including the Topographical Branch,

7 Permanent Staff Officers,

4 Officers attached after course at Staff College.

Comparing like with like, permanent with permanent Officers, attached with attached, and remembering the world-wide interests of our country, it may be said that the English Intelligence Branch undertakes much more than the work of any General Staff, with a tenth of the number of Officers. If, then, there should happen a Colonial or European war, and complete information should not be forthcoming, let not the country be too severe on the seven Officers on whom this more than Herculean labour has been laid. I am not at liberty to say exactly what is being done. We are doing our best, and have no opponents that we know of.

Indeed, it is difficult to see whence opposition should spring. The essence of an Intelligence Department is, that it is in no sense executive. It robs no one of freedom or power; it must be the servant of all, ask for information from all, and be ready to supply information in return. It is a worker for Queen, Lords, Commons, civil and military departments of the State. It neither adds to nor takes away from the number of the standing army, though it may be said now-a-days, that if there are any individuals so far in rear of public opinion as to fear the small standing army of England, their voices are but the last faint echo of a far-off cry. The pursuit of information has not, like swollen armaments, any tendency to bring about war. An Intelligence Branch of the Staff has nothing to do with classes or politics, no business except to be ever on the watch to gain, to arrange and to distribute knowledge. To perform its work honestly, in other words, to be a real serviceable institution free from all suspicion of pretence, it must have more workers, and considerable freedom in the use of the printing press. While no confidence should ever be betrayed, there can be no possible objection to publishing in English what is published in all other languages. To lock up from English Officers information which is freely distributed to foreign armies, would be to put our own service at a dangerous disadvantage. And it seems to me that no harm could, and much good must, arise from direct personal and official communication between the Intelligence Branch and those great State Departments which have all to be consulted upon warlike measures, the Admiralty, the Colonial, the Foreign and the India Offices.

Up to this time there has never been a department of the kind definitely established in England; but alas! there has never been in the history of the world any such terrible activity and earnestness in military preparations as exist at present. A very small band of officers, called the Topographical Department, were hidden in a street not far from here working, as Englishmen will work, for duty, without hope of praise or renown. All honour to them, they did what was possible, and kept up the pursuit of information during the time

when the nation was most careless about military affairs. They now form a part of the seven permanent Officers shown upon that table as the existing means of work of the Intelligence Branch.

But now, everybody who has any information to give should help us through the first difficulties, as we shall be ready to help them in theirs. Let not the novelty of the idea turn the minds of the most conservative against us. The French ought to know something about the necessities of modern war by this time, and the verdict of their Committee on Army Reorganization is contained in these words of their report. "We were beaten by want of preparation, organization, and direction, and by the weakness of our effective, rather than by the arms of our enemies." That is to say, they had done just as some few people would persuade us to do now. They had lived in a blind confidence, and refused to recognise the altered conditions of modern war. France is indeed a great and glorious nation. She is rising like the Phoenix from her ashes, but we Englishmen are a sober people, and do not love catastrophes. Ours be the natural life of reality, not the immortality of fables and dreams. As all natural life exists by perpetual death and renewal of worn-out parts, so let us live as a nation; not trembling to move because every step consumes and kills some atom or other, but by vigorous exercise and cleanly habits, pass through the natural process of renewal and improvement while retaining the grand old individuality. Or, if there must be dreamers amongst us, let their visions be of a future when, united by common sympathies and common interests, as well as by blood, Great Britain and all her colonies shall join in a bond for self-protection; when free-born men, carrying arms as an honour, shall pace the shores of the islands and continents which own the gentle sway of our Gracious Queen, and at every moment of the twenty-four hours the sun shall somewhere look down on a sentinel who cries in the English tongue—"All is well in the Empire of Peace."

The CHAIRMAN: I presume that I shall be only expressing the feeling of this meeting, as I am only expressing my own feeling, if I assure the Lecturer that we have been extremely interested by the valuable information which is contained in the hour of conversational lecture which he has just given us. As he himself has observed, there was neither time nor opportunity for going into the details which were so essential to understand so great a subject thoroughly and efficiently. I, however, think it right just to point out—because to a certain extent, perhaps, it will be assumed that I have some responsibility in this matter—that the subject now brought to our notice is one that has been brought more especially before us of late years, since the great contests which we have seen carried on in various parts of the world, and because this country has always decidedly stood in this position, that it did not mean, on any occasion, to make any aggressive war, but that anything that happened would be accidental, and, to a great extent, unexpected. I must also point out that the estimates, though alluded to very cursorily, form a very large item in the every-day consideration of Englishmen, and that everything that is spent on the Army is always scanned with the greatest care and no very favourable eye. Under these circumstances it may be very easily understood that however desirable it may be largely to add to the General Staff of the Army for the purposes so very ably brought forward by Major Brackenbury, I must candidly state that it is not very easy to convince others that such is the case. I do hope the lecture we have heard this morning may tend very much in the direction of persuading others, as it certainly did not require to persuade me, that a great deal more

requires to be done in this respect. On the other hand, I think it only right, as occupying the chair on this occasion, to say that I for one, and most others who have attended to this subject, are perfectly alive to the necessity of the points that have been brought before us to-day, but that the difficulties we have to contend with have been hitherto so insuperable that nothing more has been effected than the appointment of the small number of Officers of which you have heard. I also wish to mention—and I hope the Lecturer will forgive me for so doing—(I have no doubt that in his place I should have referred to it) another matter, namely, that the survey in Prussia has been in the hands, very much, of Artillery Officers. I am very glad to hear that the Artillery Officers of Prussia have occupations of that description and time to attend to them, and not to Artillery work. I can only say, in this country, we have been in the habit of placing the survey in the hands of Engineers, and I am not aware that hitherto that survey has not been very well performed. As to the Artillery, I for one admire as much as any man in this country, our Artillery Service. I do not believe there is anything so perfect elsewhere; but they have such very important occupations to attend to, and such vast subjects of interest from day to day (now more than ever) come before them, that I should think that if these Artillery Officers, of whom we have heard, turned their minds to their own avocation they would be more usefully and more beneficially employed than in surveying a country which may very well be left to the very able hands in which it is placed in our country. I hope you will not suppose that I wish to give the slightest offensive meaning to the remark I have made, I merely wished, incidentally, to show that the cheer with which that observation was received might admit of being re-considered after hearing the observations I had to make upon it. I wish to state, most frankly, that, whilst I should be fully prepared to deal with many of the valuable subjects, and to entirely concur in the great bulk of the observations which have been made; there are, nevertheless, points which, if I had time, I might explain to this meeting in a somewhat different light. Of course it would not be either right, proper, or in good taste on my part, or possible, as regards time, to deal with these matters on the present occasion. I feel satisfied you will all wish, as I wish most cordially, to express our sense of the very able manner in which Major Brackenbury has brought this subject to our notice; and I state with the greatest pleasure, that there is not an Officer in the Intelligence Department which has just been established and is performing its work most efficiently—for example, in this little incident with reference to Natal—in whom the Army and myself have more confidence, than the Officer who has just given us this valuable lecture.

Evening Meeting.

Monday, February 22nd, 1874.

Colonel the Right Honourable LORD WAVENEY, F.R.S., A.D.C. to the Queen, Vice-President, in the Chair.

NAMES of MEMBERS who joined the Institution between the 16th and 22nd February, 1875.

LIFE.

Murray, C. Wyndham, Lieut. 61st Regiment.
Grey, H. R. E., Commander R.N.

ANNUAL.

French, J. D. P., Lieut. 19th Hussars.

THE "MACOMBER GUN."

By D. O. MACOMBER, C.E.

My Lord, Ladies, and Gentlemen, before reading my paper, which is a short one, will you permit me to make a remark or two in relation to my appearance here this evening? A few friends asked me to deliver a lecture; I consented to do so, and, by the kind courtesy of the Council of this Institution, I have been allowed to deliver that lecture here. I do not appear here this evening for the purpose of finding fault, or even criticising, the manner of any other kind of gun-building. I am only here to explain my method, and nothing more. If, therefore, there should be, as undoubtedly there may be, those present who have perhaps spent a lifetime in the study of gunnery, I beg leave to say I defer very much to the opinion of such experience as they must have. I have only spent about thirteen years in this matter.

The construction and use of cannon or large guns takes precedence, in point of time, of that of the use of small arms, by more than a century. The discovery of the art of manufacturing gunpowder, in the thirteenth century, changed the whole principle and practice of the art of war at once and for ever. The ability to reach an enemy at a long distance obviated the previous necessity of the meeting of armed bodies of men in close proximity with the weapons then in use.

The progress of civilization has materially changed the character of

offensive and defensive arms, but has not obviated the apparent necessity for their use. If self-defence be a law of nature, it is probably as applicable to nations as to individuals, and the *preparation* for this defence implies the adoption of the most powerful and effective means of resisting invasion by any nation, however reluctant that nation may be to commence hostilities against her neighbours.

Within the present century, the importance of *artillery* on land and *heavy ordnance* on the ocean has been steadily increasing; and that the fate of many of the great battles within that period has been decided by this arm cannot, I think, be denied. Within a comparatively short period of time, the adoption of iron-clad ships of war, by almost all the civilized nations of the world, has compelled anxious attention to the construction of heavy ordnance, capable of penetrating such armour; and as iron-clad ships must and do carry heavy guns, it becomes a question soon to be settled—can ordnance be constructed so powerful and safe as to pierce the heaviest armour a ship *can* carry, at a range which will ensure safety to the attacking ship? If we construct a gun which will throw a solid projectile of half-a-ton's weight, and at a range of 3,000 feet will penetrate a 16-inch armour, and this is the utmost power of the gun, what is to be done if we cannot approach within 6,000 feet of such an enemy? Weight of projectile is all important, but great *propulsive* force is absolutely necessary to render such projectile effective. *All force* in gunnery is, as yet, derived from the use of gunpowder. The more gunpowder we can burn and entirely consume behind a shot before that shot leaves the muzzle of the gun, all other things being equal, the greater will be the velocity and force of the shot.

In greatly increasing the quantity and strength of powder from the old standard, and in using the entire power of the gases generated, four conditions are necessary:—

First. To use the *strongest* gunpowder to be obtained, or that can be manufactured.

Second. That it should be of so *fine a grain* as to enable us to pack the greatest weight into the smallest space.

Third. To *so* ignite the charge as to burn the whole in the shortest space of time.

Fourth. To use a gun, so constructed as to be fully capable of sustaining *continuously* the strain of successive discharges, with perfect safety to the gun and gunners.

To give reasons for the adoption of these four conditions, I will briefly state, as to No. 1, the strongest gunpowder enables us to get the greatest *force* into the smallest compass, and also, if we use the strongest that *can* be manufactured to commence with, we are sure that no subsequent use of a *very* strong powder will or *can* endanger the safety of the gun. Strong gunpowder, for the above reasons, is also the most economical where great force is required. As to No. 2, *concentration* of power has the advantage over the diffusal of the same, as it enables us to confine our maximum power of resistance to a comparatively small space. After the inertia of the shot is overcome, the expansion of the gases in driving the projectile to the muzzle of the

gun is in a constantly *lessening* degree, and, as a consequence, the "chase" of such a gun sustains comparatively less strain, and may be lighter and shorter than ordinary. As to No. 3.—The palpable reason for this condition is only an intensification of the two previous ones, viz., to shorten the space of time in which a given quantity of gunpowder might be entirely consumed. The perfection of this condition would be to use it in a perfectly spherical chamber, and force the point of the fire-tube into the centre of the same. Mechanically speaking, the nearest approach to this perfection of form is the oblong spherical shape of our enlarged powder-chamber, and the igniting the charge in its longitudinal and diametrical centre. As to No. 4.—This contains the gist of the whole system, and, as it will be fully explained further on, I will only say that, in my opinion, nothing short of *this* or some *similar* method of gun-building would *effectually* meet this requisition.

To subject each part *while* building to a greater strain than such part can ever subsequently be subjected to, by the use of gunpowder, is the basis of the power and safety of the Macomber gun, and forms *one* of the novel features of its construction.

For all heavy ordnance of modern construction, wrought-iron, steel, or cast-iron are used, the latter however, I am glad to say, but very rarely. With the increase of size and weight must be the *strength* of the gun. All metals have their limit of resisting force, and the *manner* of applying such force has, of course, much to do with the ability to resist it.

The discharge of gunpowder inside a gun or cylinder is tantamount to a blow given to the inner or under surface of an arch, and is of a very different character from a slow or gradual pressure applied to the same. Force is transmitted through all metals in an *appreciable* space of time. If I take six tin cylinders that are made to fit loosely one within another, and pass an iron punch through the inner one, I can strike several blows upon the punch before it begins to tighten in its place. Continuing these blows, the inner cylinder begins to tighten upon the next outer one, but I can still slip the third one off, and of course all *outside* of that. As the blows are repeated, No. 3 is rendered immovable. Soon No. 4 is in the same condition. No. 5 is fixed by a few strokes more, but still No. 6, the *outer* one, can be easily slipped off. Now, it is quite certain that, up to this point, No. 6 has taken no part in the resistance to my blows, which, however, I have been obliged gradually to increase in force, up to this time. I now have the united strength of five of these tubes or cylinders to resist the expanding force of my blows upon the inner one; but it is equally clear that *only* five have yet felt the force applied. Placing No. 6, the outer one, in its place, a few more heavy blows render that immovable. If I continue driving my tapering punch, I have the united resistance of the whole six to overcome. But how am I to *prove* that this is the case, and that the outer cylinder *does* now take its full share of resistance? Thus:—I continue driving, with still heavier blows, until the outer cylinder, No. 6, begins to expand, and until every blow I now strike

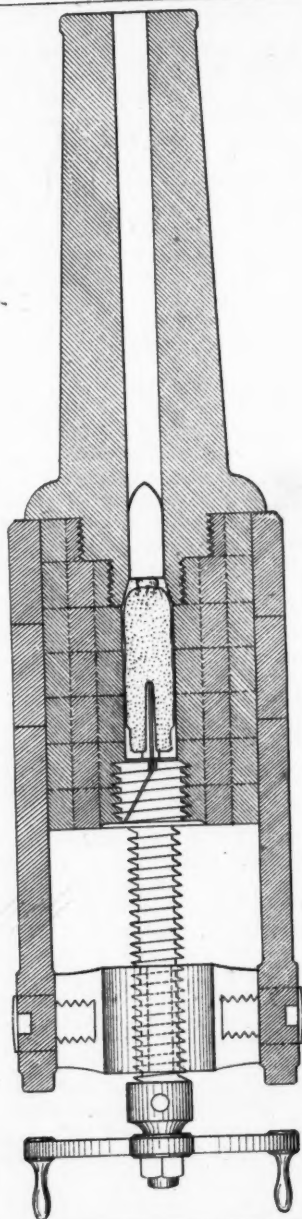
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THE MACOMBER GUN.



J. Jobbins

upon the punch increases the diameter of the united set of six tubes or cylinders.

This rude experiment, and perhaps ruder description, is only an exemplification of the transmission of force through the body of metal surrounding the powder-chamber or cartridge of this or *any other gun*, and it is to enable me to overcome this unequal pressure between the inner and outer surface of the gun, that I use three different kinds of wrought-iron, in forming the entire breech of my gun. The amount of the inequality of this pressure is differently estimated by different writers upon the subject, some carrying it as high as eleven times, and some as low as four times greater on the inside than the outside, the ordinary tabulated strength of metals having little or no bearing upon the question. One of the most celebrated of the compilers of these useful tables in London, informed me that he was in possession of no reliable data by which he could give even an *opinion* on this particular subject. Fortunately, however, there is a very accurate method of overcoming this unequal strain, *whatever* may be the amount of it, and by the use of which, *all* the resisting power of the metal of a gun may be brought into practical use, at the instant it is wanted, by the sudden expansion of the gases in the instantaneous burning of quick gunpowder.

A blow struck by a steel hammer upon a metallic surface is as sudden in its effects upon the point of contact as would be the effect of the discharge of gunpowder, of the same *relative force*, upon the same surface. No gradual pressure of the same force can equal this concussion and instantaneous effect. The interior of the barrel or chamber of a gun is the under side of an arch, and the quick discharge of gunpowder in the chamber is a blow given on the weakest portion of that arch. As all gunpowder when ignited discharges its gases in every direction alike, we are thus certain that each square inch of the chamber in which it is contained will receive its exact proportion of the strain. By dividing the receptacle or chamber of the charge into transverse sections, we arrive at the maximum resistance which each section must bear. If we now subject each of these sections to a series of blows, much greater in force than will be the proportion which it will be called upon to bear when the burning of the charge takes place, we may, I think, safely trust to the resisting power of the gun. To test this resistance of the metal, various plans have been proposed.

Construction.

Evading all comments on the mode of building *other* guns, and coming to the method of constructing my own, I may be allowed to quote from one of the most practical and experienced English writers on this subject. He says—

"The material should possess hardness sufficient to resist the shock of the projectiles; should be capable of resisting the chemical action of the air, or of the compounds generated by the combustion of gunpowder, and augmented in their destructive agency by the heat produced by ignition; should possess sufficient elasticity to resist a

"disruption of continuity, or a permanent change of condition, resulting from the vibration produced either in rapid transport or by frequent discharges; and also a tenacity sufficient to resist the enormous pressure exercised by the elastic gases at the first moment of their development."

The above requisitions seem to be fully confirmed by a titled author, with whose writings most of my audience are probably familiar, and who with less elaboration, but still stronger language, says—

"In the art of gun-making, the highest point to be attained is the construction of a piece of such strength as to curb the utmost force of whatever explosive compound can be used within it. The *beau idéal* of a perfect gun, is one which will give the gunner the positive mastery over gunpowder, in other words, a gun which *cannot* be burst."

I know of no more comprehensive and correct definition than the above to the important question, what is required of the *most perfect* heavy ordnance which can be built? and in describing my own method, I have no wish or intention of condemning any other mode of gun-building, either in material or form of construction.

It is only by various opinions, methods and experiments, and different inventions, that progress can be made in this or in any other art. The only exception that I will allow myself to make is that I do not, and *cannot* believe in the use of *cast-iron* for heavy ordnance, and I attribute the high position now held by England in manufacturing heavy cannon, to her early breaking away from the use of that most brittle material for such purposes.

Equalizing the Strain.

Remembering the fact already stated, of the great difference in the strain, between the inner and outer surfaces of a heavy gun, at the instant of discharge, and the liability of a fracture to the former, before the latter has time to act as a re-inforce, I begin by overcoming this difference and entirely equalizing this strain, and bringing the whole resisting power of the breech to act at the instant of discharge. In calculating the force of a projectile, it is quite certain that it must be in proportion to the *amount* and *strength* of the gunpowder used; and all *other things* being equal, we cannot get a great amount of force from a small amount of powder. The quantity of gunpowder ordinarily used I believe in heavy guns (for of such alone I speak) is from *one-sixth* to *one-fourth* of the weight of the projectile, and in a few instances of moderate size calibre, of *one-third*, but usually *decreasing* the proportion with the *increase* of the weight of the projectile.

Determining first the weight of the solid shot, my practice is to use *one-half* this weight in the *strongest fine* gunpowder which can be procured. I then *know* that no subsequent use of gunpowder can exceed in force or power that which the gun has been constructed to bear. The *chamber* of the gun is proportioned in size to a capacity to hold without much compression this amount of fine powder. To form this chamber, and the breech of the gun (which is constructed separately

from the chase, and afterwards united with it by a very strong double screw), I make use of

Discs

of wrought-iron, and of my own invention, which have never been used for guns, or for any other purpose in this country up to the present time, and the peculiar construction of which was entirely new, until I patented the same. These discs are composed of three different qualities of wrought-iron, the softest forming the centre, and the hardest the outer circumference of the disc, and are thoroughly welded together, leaving a hole in the centre. After a sufficient number of these are prepared to form the gun, they are roughly engine-turned to bring them to a uniform thickness, and also to discover if any flaw or imperfection in the welding is to be found, and if there is, *that* disc is rejected and another substituted in its place. These discs are then submitted to a process of "setting" by steel punches (each disc separately) by powerful blows of the steam-hammer, beginning lightly and increasing gradually until the soft and hard metal has been forced (in a cold state) from centre to circumference to the point of enlargement of the latter, which *commencement* of enlargement is *proof* that every portion of the disc *will* bear its equal proportion of any future strain or concussion which it may be subjected to, and which, in the use of gunpowder, cannot exceed the test thus applied.

In Kert's "Treatise on Metallurgy," he lays it down as a rule, "that in wrought-iron, the *strength* will increase the more finely it is "drawn out." All of us know what immense strength and tenacity were to be found in the so-called "stub and twist" gun-barrels, which were forged out of old stubs and points of horse-nails. Some of the laminated steel barrels now in use are external limitations of the same.

After these discs are set, they are welded one at a time upon a mandrel by the process known to smiths as "jump welding," and as the centres of the flat of the discs are left a little raised, that portion unites first in welding, and thus presses *out* the scale, that might hinder the perfect union of the metal. Subsequently the mandril upon which the discs were forged, will be entirely taken out by the process of boring the gun, leaving only the metal which has been subjected to the steam-hammer and punch.

Steel Rings.

After the breech is finished, as above described, it is then accurately and smoothly engine-turned externally, and a proper number of steel rings *opened* and forged, without welding, so as not to break the continuity of the metal, are accurately fitted to the exterior of the breech, and are forced (without heat) over the same by a powerful hydraulic press, one at a time, and on one the "trunnions" are forged. For the gun before you, a power of 144,000 pounds was used.

If it should be deemed necessary in the construction of a *very* heavy gun to add a second series of rings over the first, it can be done with perfect ease, and great additional strength. For reasons previously

alluded to, the *chase* of this gun will require no supplementary steel rings, the strain upon it being *less* just in proportion as it is *greater* than ordinary on the breech. After the whole is finished, in accordance with the above, and the mechanical *setting* and strain have been duly applied during the construction, such a gun may be worn out in time, but it *cannot be burst with gunpowder*.

Setting of Metal.

To show that the *setting*, or enlargement of metal to obtain the full power of the outer portion of the same in gun-building, is correct in *principle*, allow me to quote from one of the most celebrated gun-builders and mechanical engineers of England, one who has certainly expended as much time and money in experiments of make and material as almost any man now living. He thus describes, in his own words, *his mode of proving guns*. "It consists in preventing the shot from moving, when the powder is ignited, the gases generated by the explosion escaping through the touch-hole. About one-sixth of the regular powder charge fired in this way gives the same strain to the gun as a full charge fired in the ordinary manner. To prevent the movement of the shot, a screw is cut on the periphery of the gun at the muzzle, and on it is fitted a screw cap, having a solid end. The gun is loaded with a cartridge of the ordinary length, but containing one-sixth of the regular charge, and supported by tin discs in the centre of the bore; a flat-fronted shot with light wads to prevent any escape of gas, and a round steel bar reaching from the shot to the end of the bore are then introduced, and the cap with the solid end screwed on.

"The gun is then ready for firing, after which my measuring instrument is introduced into the bore, and any enlargement to the 10,000th of an inch in extent may be ascertained. If there be no enlargement, the powder charge may be gradually increased, until a slight enlargement has been produced. The strength of each gun is thus positively ascertained, and this strength I would have recorded and stamped upon each gun. This would give confidence to the gunners, and would act as a check on those engaged in the manufacture. When the ultimate endurance of any particular kind of gun is thus ascertained, the regular powder charge, or any less quantity deemed advisable, may be used, the enlargement being recorded after each discharge. A 9-pounder bore gun, made of my metal, but reduced to 12 inches diameter, has been so tested, and has had 18 full charges of $1\frac{1}{2}$ pounds fired from it. The expansion in the bore is now 1903 inches, and that of the outside diameter is .0483 inches."

You will observe in the concluding part of this very accurate measurement of the enlargement of a gun by the force of gunpowder, that this enlargement by increasing charges, was, when completed, found to be nearly *four times* greater on the *inside* than on the *outside*, thus proving that the metal was compressed until the strain reached the outer circumference, thus equalizing in a degree the whole mass of metal, and then, and not till then, the experiment was deemed suc-

cessful, and the test firing suspended. Instead of finishing a gun, and then expanding it with gunpowder, I prefer to accomplish the same thing by mechanical means during the construction of the same.

Gas-check.

One of the greatest objections made to heavy breech-loading guns is the hitherto almost insuperable difficulty of *entirely* preventing the escape of gas at the breech. That I have, after many experiments and much labour, succeeded wholly in accomplishing this, those who have been present at the firing of this gun can testify.

The gas-check is formed or placed on the end of the breech-screw, and is made of solid steel staves, strong, thin, and elastic, and firmly bolted on to the screw, and in the form of a cylinder, enters the rear of the powder-chamber as the screw is driven in, and the chamber being slightly diminished towards the muzzle, these staves are *compressed* as they enter; and, being very closely fitted to the inner walls of the chamber, they enclose one half the length of the charge at its base, and being bevelled to a thin edge as they enter, they cut away all fouling of previous charges to the extent of their own length, and thus keep smooth the chamber against which they are pressed. When the discharge takes place, as about half of it is within this cylinder of staves, it presses them more firmly against the walls of the chamber and prevents any escape of gas between the two. As these staves are made in a number of separate sections, if one is found to have been injured, it can be removed in a few moments, and another always at hand substituted in its place. This method of forming the gas-check is cheap as well as effective.

Fire Tube.

This gun is loaded by placing the projectile into the rear of the rifled bore, then the bag of powder or cartridge into the powder-chamber. Two turns of a four-threaded screw close the rear tightly, and the gun is ready for the primer. I use Dyer and Son's friction primers which I now find well made and effectual. The primer drops into an orifice in the top of the closed screw close to the base of the breech. The fire is communicated to and *into* the charge by a fire-tube which enters its base, and is long enough to penetrate to the centre of the same. This tube may be steel, platina, or any other metal best calculated to resist the effect of the concussion. It is screwed into the end of the closing screw, and is of course surrounded by the staves of the gas-check, and if one is injured it can be instantly removed and another put in its place.

Force.

It will be seen by my description thus far that the object aimed at in the commencement has been kept steadily in view, viz., to burn the largest amount of the strongest gunpowder in the shortest space of time, and that the gun shall be able safely to resist the strain of such discharges for an indefinite length of time. The test of powder in this and all other guns must be judged of by its execution in *initial*

velocity, penetration, and range. And this naturally brings us to the recollection of a name justly honoured throughout the civilised world, a name at the very mention of which every Englishman's heart must warm with pride and gratitude, and I trust not less in America than in any other nation,—the name of Isaac Newton. He taught us the rudiments of those immutable laws of nature, by which all bodies in the universe are governed, and by which we know that on this globe a dense body falls sixteen and a half feet (and a fraction) in its first second of descent towards the earth's centre.

To temporally overcome this law of gravitation we employ *force, power, energy*, whether of gunpowder or any other material to propel shot or shell on a plane parallel with, or above the surface of, the earth. *Force* or *power*, then, is what they want in war, and the greater the amount of this power used at a given moment, the longer will be the range and the deeper the penetration of a projectile, behind which this power is made to act. There is, perhaps, no more beautiful and interesting an experiment to a scientific and practical man, than testing the accuracy of the law of gravitation in the firing a cannon *levelled* by an instrument over a perfect plane, the gun being firmly fixed at an elevation of just $16\frac{1}{2}$ feet above the surface, and then being able to find the exact point of contact of the shot with the surface of the plane. No "chronograph" would then be required to determine the velocity, as the flight of the shot, from the muzzle of the gun to its touching the surface, as well as the dropping of a like shot from the gun to the surface immediately under it, would exactly occupy the one second. The elevation of the muzzle of a gun to say 38 degrees for throwing shell, increases the strain upon the same, but a surplus of power and strength is held in reserve for such occasions by a gun of this kind, my aim being to apply the principle to heavy siege guns, and for penetrating ironclads with steel shot at a long range, *force* and *power* being the object. In the war of the elements, it is not in the roar of "Heaven's Artillery" that we fear destruction; but in the sharp silent flash of ignited electricity which *kills* long before the report can be heard by human ears, and which is never heard by the victim of its lightning power.

Powder, Loading, and Firing.

In the use of the best and surest means of obtaining the highest results of force in explosive material, I select the strongest powder and of a fine grain, that I may pack the greatest weight into the smallest compass. I would have no hesitation in using an amount of gun-cotton which would represent in force the gunpowder for which the gun is gauged. But I have not been able to procure the guaranteed force of a given weight of gun-cotton exploded in such a chamber as we use. Strong *gunpowder* I have found, and I am certain it *is* the *strongest* I have ever been able to obtain, either on the Continent or in America; and, that I may not be misunderstood in this essential particular, I take the liberty of giving a copy of the letter of Messrs. Curtis and Harvey, whose great kindness and courtesy to a stranger on that occasion I here desire to acknowledge and thank them for.

"London, Jan. 1875.

"D. O. MACOMBER, Esq.,
"10, Arundel Street, Strand.

"Dear Sir,

"In compliance with your request, we beg to state that an experiment took place in our factory at Hounslow on the 23rd of December, 1874, with a gun represented to be your invention.

"The weight of the gun is 12 cwt., the calibre $1\frac{3}{4}$ inches. Two shots were fired, the charge of gunpowder being $1\frac{1}{2}$ lbs. of treble strong, No. 3 (our manufacture), and a conical shot weighing 3 lbs. Both were weighed by us.

"The first shot was fired to ascertain that the gun was properly laid. The second shot was fired in connection with Boulanger's chronograph; and, although this instrument was not arranged to record accurately over 1,500 feet per second, the actual velocity of the shot exceeded 2,000 feet per second, as far as we could estimate.

"We are,

"Yours faithfully,

(Signed) "CURTIS & HARVEY."

The process of loading a heavy gun of this kind, and of which this is but a "working model," is simple and rapid. Two gunners standing in the rear of the gun (by the breech of which they would be protected from the shot of an enemy in front), and one of them on each side of the loading screw can load and fire such a gun twice in a minute, if such rapid firing was at all desirable.

After a discharge, and the gun is opened, they pass the shot through the powder-chamber into the base of the rifled chase, over a cushion fitted to protect the thread of the screw. The cushion is then withdrawn and the "charge" in a sack is quickly lifted to its place in the chamber. The closing nut and screw is turned one quarter round until it is stopped by the guard pin; both gunners then seize the crank, and two turns of the four-threaded screw drives the fire-tube into the centre of the charge, and the gun is loaded. One gunner now drops in the friction-tube, attaches the hook of the lanyard to the loop of the primer; both step back, and one pull discharges the gun. The screw is then turned back to its full extent, swung round, and the interior of the gun is open its whole length for air and inspection.

Perhaps it is needless for me to say that the shot being leaded to take the rifling of the bore, and in such a manner that the leading cannot "strip," all windage is prevented, and consequently there can be no "erosion" of the interior of the chase.

It seems to be too true that war was the normal condition of mankind in the earlier ages of the world. From that period to the present moment, the average sacrifice of human life in battle has irregularly, but steadily diminished. The reliance now, and for many years past, in the gage of battle seems to have been placed upon

artillery, and the fact that this arm of war has decided the fate of many of the prominent battles of the age, and has, in addition, greatly diminished the former loss of human life, might almost bring to its favourable consideration the venerable President of the National Peace Society.

When pitched battles come to be fought between modern armies with improved guns and at five miles apart, *suspension of hostilities, capitulation, and peace* may follow, but the loss of human life will be almost nil.

The CHAIRMAN: Mr. Macomber would add very much to the interest of the meeting if he would be kind enough to give a further explanation of the manufacture and application of the gun.

Mr. MACOMBER: I spoke first of the manner in which the chamber is built from discs. I have here a disc composed of three rings, the inner one rather soft, the next one a little harder, and the outer ring the hardest iron that could be used. When these are put together they are thoroughly and fairly welded into a disc, and then any defect can be seen, or if not visible then, the rough turning of the lathe gives to the surface a sufficient smoothness to show if there is the least defect in the welding of that disc. If there is, it is rejected of course: if there is not, it is ready for use. After a sufficient number have been thus made, we take a mandril and begin by welding one on to the other, "jump welding," which is hammering on the top and the side. This is done in the hot state, but only one at a time. If that is found to be perfect it is allowed to go on; if not it is replaced by another. Then another one is heated and welded on too.

Capt. SCOTT, R.N.: Are the lower two heated again?

Mr. MACOMBER: No, as little of heat as possible, for those that have been already welded. Then comes another and then another, forming the breech of the gun. Inside of this is the powder chamber, and you will bear in mind that all this material of the wrought iron is in the very best form to resist the pressure outward, and when this is all done then it is again put into the lathe and roughly turned to see if there be any imperfection in the welding of the discs together. This then forms the body of the gun. I have here a disc made as I have explained. A steel punch was introduced into this centre orifice and driven in with very powerful blows. The orifice was originally three-fourths of an inch in diameter, it is now $1\frac{1}{8}$ inches. What has become of the material? It has been driven out; the last punch was driven with a powerful 12 lb. sledge-hammer swung by a very powerful smith, a full blow, and at last the circumference began to enlarge. With an instrument ready we ascertained that we were beginning to enlarge the disc, and at the last blow struck upon it, it expanded the $\frac{1}{16}$ th part of an inch. This is merely to demonstrate the fact that the outer side, if you go on punching, will continue to expand. You get, therefore, the whole power of the iron, and that is just all there is in that part of the disc system which I claim, will resist. Suppose this was two or three inches, of course the punch would be in accordance with the size of the gun to be used, and as I said before, every blow struck upon it, is like a discharge of powder on the inside, that is to say, it is as quick in contact as it would be, if it received that proportion of powder. After a sufficient number of these are made to form the breech, then they are made into the required shape. This is the breech of the gun, manufactured entirely separate from the other parts. These discs form the breech of the gun, and over the powder chamber particularly they are welded together to form what you see there. The chase of the gun does not require any steel rings on the outside, because the greatest portion of the force of the discharge passing through the breech, the comparative force through the chase is much less than ordinarily. The powder is entirely burnt before the shot reaches the muzzle. To prove that, I fired the gun over a lake twelve miles long and two miles wide, frozen solid, with a very fine and beautiful coat of snow upon the ice. It thus gave me the opportunity of testing that beautiful principle that I alluded to, and also of ascertaining that not one particle of the powder fell upon the snow unburnt,

which was the object I had in view. I will now show you the steel rings. These rings are not welded but opened and continued. These are forced on to their places by a power that is sufficient to press them down. If it is a large gun, it requires a very powerful hydraulic press; as I said before, the one we used in making that gun was 144,000 lbs., and there are four of those rings forming that breech. These rings are put on one at a time and forced on. In this case there is no heat used, that is to say they are not put on by contraction while the metal is cooling. After this is made, the whole is put together by a double screw, enabling us to build these guns in parts at different places and with the most perfect mechanical accuracy. The breech screw is a four-threaded screw, and two turns load the gun. Now in case of disruption what is to be the result? All this strength must be torn out from the rear; the screw must be torn away; the solid nut must be torn away before there can be any explosive force that could injure that gun at the breech. I fired a similar gun to the one now before you, no less than 280 times, and when I left it in France (I do not know what became of it after that, I believe the Germans got it), it was as perfect as when it left the machine shop. I have here specimens of the shot that we use, showing how they are leaded. The lead is held on by half holes drilled in the shot itself, and I have never known one of them "strip." The shot itself is leaded to take the rifling, and is kept in a straight direction by being held firmly by the base. If it were a longer shot, of course it would have a longer leading and a deeper groove. A shell to be thrown by a gun built in this manner, of course would not be quite so heavy as the solid shot. I have one here of precisely the form and style in which we used them when we were practising for range on Fire Island beach, off Long Island. The sabot falls off within a few hundred yards of the muzzle of the gun. This portion is filled with the lead which takes the rifling. When the elevation was 38°, that was sufficient to support it, while at the same time the shot was smaller somewhat and more pointed, and after this had dropped off, the shot attained a range of 9½ miles measured with Gunter's chain.

Captain KERR: Was not that gun tried on board the "Excellent?" and will you kindly state what took place there?

Mr. MACOMBER: The gun was, by the consent of the authorities, taken to the "Excellent" at Portsmouth, and thence on board the "Netley," and, under the superintendence of Captain Boyes, was fired for penetration only. The distance, however, was only about 30 feet from the muzzle. The targets were 14 inches thick and had been used for heavy guns that were fired in position there. I told the Captain that my shot for that short distance would not strike point on, and it did not; for I will mention what is probably known to most artillerymen, that a rapid shot thrown from a gun of this kind, whether a small or a large one, has three motions instead of two: there is of course one forward, and one other upon its own axis, and besides that, in shots from this gun and from those that have a very high velocity, the shots have when they leave the muzzle of the gun a screw motion, but, in a short distance, they settle down and then go straight on. In testing this gun at Vincennes, at 120 yards, I was obliged to move it back 170, because the shot struck sideways, they had not settled. Moving it back, however, to 170 yards, the shot got point on and penetrated three inches of iron backed up by some 12 or 14 inches of oak. There was no instrument on board the "Excellent" to measure initial velocity. Subsequently the gun was fired at Fort Cumberland, and there was no instrument there for that purpose. I have not been able to find a place for testing initial velocity.

Captain KERR: You say it was 2,000 feet?

Mr. MACOMBER: Something over 2,000 feet, as estimated by Messrs. Curtis and Harvey.

Mr. JOHN MACINTOSH: Is the punching of those discs done in a cold state? and is there any crystallisation?

Mr. MACOMBER: Always cold. We never have had it; it was examined very closely with that view.

Mr. MACINTOSH: It seems to me the most vital point, universally considered by artillerymen, that the powder gas strikes with a blow of about 40 tons to the inch, and that a repetition of these blows crystallises the metal, and deteriorates

the gun. You commence by striking the iron perfectly cold, and do mechanically what is done chemically by the powder; it is of great importance that the doubts of mechanicians on such a theory should be promptly dealt with, especially as to the causes of that enormous resistance you speak of. I think it is generally considered by mechanicians that striking iron with such enormous force as you speak of, will crystallise the metal. Now, if you can obtain a range of nine miles and a quarter by your gun, and by the perfect combustion of strong powder, it is one of the most important subjects that can possibly be conceived. With such a range as you speak of, that gun placed in a vessel of great speed (which is an element of success in naval warfare), could be used for firing incendiary shells into harbours, towns, and among shipping, at a range at which an ironclad would be useless. These are matters of the greatest importance, and ought to be discussed, and if you have succeeded in accomplishing your object, I must confess that it is beyond doubt the greatest improvement I have ever heard of in gunnery.

Mr. VAVASEUR: Will Mr. Macomber kindly state what is the weight of his gun, the weight of the charge and the weight of the projectile, because from what he said I believe the performance of his gun has been exceeded, as far, at all events, as range is concerned, and I think as far as velocity is concerned. The gun I refer to is a breech-loader weighing 9 cwt., with a 3-inch bore; the projectile weighs 10lbs., and the velocity is 1,968 feet.

Captain KERR: Where measured?

Mr. VAVASEUR: At Calais.

Captain KERR: What was the charge?

Mr. VAVASEUR: 3lb. 3 oz.

Captain KERR: Mr. Macomber has stated that his gun would take a charge half the weight of any projectile he can apply.

Mr. VAVASEUR: But the question is what is the amount of velocity?

Captain KERR: He said it had been tested up to 2,000 feet.

Captain McEVoy: I should like to ask the way in which the gas check is arranged; and also whether this gun is not the same as a gun exhibited in Paris under the name of the Ferris gun.

Lieutenant BOWER, R.N.: Mr. Macomber has drawn attention to the performance of the gun, but there are one or two points I should be glad if he will explain to us. What would be the effect of a shot striking at the end of its journey? The shot seems a very small one as compared to the size of the gun, which is 12 cwt. Our 20-pounder Armstrong weighs 13 cwt., only 1 cwt. more. I understand that this gun is not to be used in the field where shell-power is all important. But if it is placed on board a wooden ship, shell power is of even more importance than actual range. Our present shells are very effective up to 2,000 yards; and beyond that distance, considering that you never have a steady platform at sea, it would be extremely unlikely that you would hit your enemy; ships that mean fighting will come within that distance. Shell power, therefore, is of the greatest importance, and the size of the shell and the effects it produces on arriving, are of even more importance than the actual range and penetration, especially against wooden ships. In the case of ironclads, where the shell would not penetrate and this shot would, I admit there would be a manifest advantage for this gun, but our present guns can penetrate the majority of the ironclads at present afloat in European waters, and if our shell did penetrate the broadside of any ironclad, the difference of the effect after arriving inside, as compared to the shell of one of these guns, would be very marked. The effect would not be confined to the mere explosion of the shell, but the effect of the explosion of a large charge of powder in a close battery would be sufficient to stun and choke nearly every man in the battery, and to place them *hors de combat* for the remainder of the action. I should like Mr. Macomber to give some more particulars as to the effect and striking force of his shot and shell.

Mr. NURSEY: Mr. Macomber having recommended this gun for heavy siege artillery, has he gone into calculations as to what would be the weight and dimension of, say, a 12- or 15-inch gun? Perhaps he can favour us with some approximate idea.

Captain R. A. E. SCOTT, R.N.: I think I am right in looking upon this gun as

merely a working model; and of course, whenever one commences a series of experiments, it should be with a thoroughly strong gun. I do not think we can in fairness ask Mr. Macomber how much lighter he could make a gun on his principle, for that, after all, is a practical question. This problem has been worked out in England so far that we know what weights are necessary for our present description of guns. Nor do I quite agree with some of the remarks made as to the size of the shell of Mr. Macomber's gun, because you can easily lengthen the shell. The thing Mr. Macomber brings prominently before us is his method of building guns. I cannot agree with previous speakers, as to the effects of heavy charges of gunpowder; for I have never seen any damage done to the powder-chamber itself; the damage is always done where the gas rushes past the shell, or re-acts against the bottom of the bore, but if the windage be perfectly closed, there will be no damage done to the chamber. The erosion in the bore of our own guns is occasioned by the escape of gas over the shot. With studded projectiles and the large rifle grooves in which the studs work, there is a considerable escape of gas, and it is exceedingly difficult to prevent this, as the studs in no way fill the grooves. The consequence is, that our guns are very short lived. No doubt that the erratic movement of the shot in the bore greatly tends to destroy the gun. I think Mr. Macomber fails in the method of rifling, nor can I agree at all with what he says as to great velocities *necessitating* the point of the shots circling round (like an unsteady peg-top) out of its true path on leaving the gun. The fact is that the shot does not leave the gun properly centred, which is due to its rotation being imparted by the lead on its base. This lead is of larger diameter than the rest of the shot, and, therefore, the point of the shot drops in the bore of the gun and takes a circling movement on leaving it; and, therefore, does not fly straight until after some time. I cannot look upon this as detracting from the principle of building the gun or the principle of closing the breech; and although something has been said about shell power, &c., there is no doubt but that in an action at sea, you want the very highest velocity with the flattest trajectory possible. Unless given a very high velocity, projectiles will not penetrate on striking at acute angles. When we speak of our own shot penetrating certain thicknesses of iron, we merely mean when such are struck at right angles. This is, however, the exception in a naval action, and I fear we shall find that our shells will not usually penetrate. The courses of experiments have been made with firing at right angles; and we, therefore, do not really know the strength or penetrative power of our shells, so that their effect is mere speculation. I think we ought to be very much obliged to Mr. Macomber; and, as a member of this Institution, I feel great pleasure in thinking that here any gentleman can come and state his views openly and meet with the support that they merit. Although I may not agree with the details of Mr. Macomber's plan, I certainly do think that its merits entitle it to be very carefully considered. At the present time our own guns are short lived, give a low velocity, have small endurance, and the projectiles are, in my opinion, wholly unreliable.

Mr. MACOMBER: I have great pleasure in replying as far as I can to the enquiries made. It is for that reason I have come here, and I, therefore, am more pleased even with the objections raised, than I should be with a tacit consent to everything that I had stated. Captain Kerr asked questions with regard to the velocity of the shot, and also as to the discs, their power of resistance and so forth. Some portion of this will become so entirely *apropos* when I show the gun itself and its operation, that I will pass it for the present, and will answer the gentleman who asked in what respect this gun differs from the Ferris gun, shown at the Exposition in 1867. That was my gun; I built it, and for thirteen years, with that man at my right hand, I worked at it, and it is that gun that I should have been happy to have shown here, but unfortunately, when the war broke out, that gun was at Vincennes, I then being in negotiation with the French Government to purchase it, and all the preliminaries having been settled except the details, and where the large gun was to be built. The gun was at Vincennes, subject to my order, and I remained until about the last thing, and then came away glad to get out of the city without any gun. When the war was over I went back and that gun was not to be discovered. I had previously brought away the gas check and the end of the screw, and that is a part

of this gun, which shows, of course, it must have been exactly the same size. I made some improvements and patented this gun in England myself, but the Ferris gun was virtually the same thing. I built it, but whether he or myself was the original inventor I will not undertake to say. He is a gun-maker of extraordinary celebrity at home and he came to me and we worked together.

With regard to the velocity, I would simply say that experience brought me to this conclusion:—I found in all cases where the target was within say 100 or 50 yards as the minimum, the shot invariably struck at an angle. When firing the gun at Vincennes, I used a long blunt-pointed shot. The first shot I fired at 100 yards, struck sideways on the target, which was 3 inches thick with a backing of 14 inches of oak, and absolutely bounded back to within a foot of where I was standing. I then had the gun moved backwards until I had a full 150 yards, and the next shot penetrated 3 inches of solid wrought iron. In relation to the erosion I can only say that there is no windage in this gun. I do not say what it would be with a larger gun, I only say that is the largest gun I have ever built, but the lead fully and thoroughly filling the grooves and the lands, there can be no windage at all, consequently there can be no erosion.

As regards the blow that is struck, you will bear in mind that gun before you is made with 13 rings from one end to the other of the breech. They cannot, therefore, be very thick, and I maintain that the blow struck with that 3-ton hammer was greater than that portion of the chamber will ever receive as the maximum of its resisting power, and that no pressure exerted by the discharge of the largest amount of powder that could be used in the gun, would be so powerful as that to which these very discs have already been subjected. Another thing that should be borne in mind, is the facility given for constructing the gun in different parts. I can build the breech separately without the incumbrance of the chase, and as it is here where the great strain takes place, so also it is here where the metal offers the greatest resistance. I can only speak from experience in a matter of this kind, and as I said before, I fired the fellow to that gun 280 times, and it was as perfect when I last saw it, as it was when it left the hands of the builders.

In relation to the strength of the powder, I take it for granted that all guns must necessarily be strained in proportion to the amount of strength of gunpowder that you use. If I use the strongest and the largest quantity, then I do not know how that can be exceeded. The original of this gun was intended to be bored out to make a 6-pounder. The chase is just that much smaller than it would be if it was as it was intended to be, for a six-pound shot instead of a three. The gun was applied for for the Japanese Government at one time, and it probably would have been sent there if I had found the gun and had returned to the United States.

The CHAIRMAN: We have now been discussing at some length the *rationale* and construction of this gun, which is the main point we have to consider. We all know the short life of our heavy guns in consequence of the destruction of the bore by combustion of the powder. That is the thing against which I believe Mr. Macomber has striven, and it appears to me he has striven against it very successfully indeed. In this gun I find traces of genius which are unmistakable, I call that an unmistakable result of genius, which is equally fitted for the particular purpose for which it was originally intended, whatever the circumstances of size, of proportion, of use, or of action may be. Speaking of our guns of the old school, which suffered so much from the combustion of large quantities of powder, there was evidently some variable quality difficult to obtain, which would be represented, as I apprehend, by the tenacity of surface in that portion of the bore exposed to combustion, and which should be equivalent to the largest force disengaged by combustion of the charge, that is to say, probably latent power of resistance to an increased charge: that is the tenacity of material should be as the square of the additional charge of powder. A 20-pounder gun would, therefore, require less tenacity of chamber or bore to resist the disruptive forces of the charge, than a much larger one. That was the difficulty, and it has been got over, to a certain extent, by the employment of pebble powder.

I find in this gun a particular process adopted by which the power of resistance is taken to be the equivalent to the largest possible disruptive force acting within the bore itself; and it naturally occurred to me, not knowing precisely the principle

upon which this material was put together, that, as the size of the bore increased, and consequently force of combustion, the material, if it was merely in a crystallised state, as has been remarked, would in the larger class of guns require a greater power of resistance than could be obtained by ordinary means. But, according to the principle of Mr. Macomber, the force which forms the chamber, is itself always increasing in proportion to the necessity of its exertion, that is to say, that the larger steam-hammer gives a closer and greater density to the rings on which it is exerted, than the disruptive force of the larger charge of powder can overtake. That I take to show the genius of this discovery, because it matters not whether the gun be constructed to throw a 500 lb. shot, or the small shot that we have seen, in regard to its power of resistance. For as that force of the steam-hammer and punch, which has given the capacity for resisting explosive action in the smaller chamber, is proportionally powerful in regard to the larger chamber, therefore a gun of whatever size, if it can be fabricated at all by such machinery, must possess such a power of resistance to the charge, proportional to the bore, as has been obtained in the small gun.

Mr. MACOMBER (after removing the breech of the gun, and explaining its construction) said: A sheet of white paper was laid on the rear when the gun was fired on board the "Leopard," and there was no discoloration, no escape of gas.

The CHAIRMAN: I think I understood you to say, the combustion was perfect, and that no grains of powder were left on the snow?

Mr. MACOMBER: Not a particle. The white snow on the frozen surface of the lake enabled us to see if there was a single particle, for the nitre and charcoal would be discovered at once as it fell upon the white snow. That enabled us to determine clearly that the entire charge was burnt before it left the muzzle of the gun.

Captain BURGESS: Was it on the lake you got that range of nine miles?

Mr. MACOMBER: No, it was afterwards, on Fire Island Beach, which is said to be the only place in our country where such a range can be obtained, and the shot found. As I said, measured by Gunter's chain, which I purchased for that purpose, the range was $9\frac{1}{2}$ miles. I, with reluctance, mentioned that for this reason: I think I ought to confine myself entirely to the experiments and trials that should be given to this gun in this country; but I am ready, and should be most happy, to have an opportunity of testing the range in that way. I am told by the best artillerymen here, that if I get the initial velocity settled, they can calculate the range at an elevation of say 38° ; of course the range is regulated by the force of the powder, and I do not hesitate to say, that every opportunity that I have had I have embraced for the purpose of testing range. I could find none satisfactory in or near Paris.

Captain SCOTT, R.N.: With a charge half the weight of the shot, there is not the slightest doubt you must get a velocity of over 2,000 feet a second.

Mr. MACINTOSH: In reference to the perfect combustion of the powder, your test was over a horizontal plain, and the unburnt particles were presumed to gravitate on to the white sheet. Now I have found in using strong fine powder that it is blown into the air to a great extent unconsumed. If you had a sheet held perpendicularly, and one placed horizontally on the ground, at a certain distance from the muzzle, it would obstruct the powder, and I have no doubt abundant particles would be found on the horizontal sheet. I suggest that it is an element of the utmost importance to use the greatest quantity of strong powder in an enlarged chamber, and thus to get perfect combustion.¹

Mr. MACOMBER: You will see at once by looking at the gun, that the fire-tube penetrates the charge to the centre, and when combustion takes place, it has only to burn half of it, because the other half burns equally the same, and, therefore,

¹ I would remark that the range could be easily obtained by putting the gun on a steam-tug, and going to a suitable place, anchoring the tug and a boat nine miles apart, and then firing one of my incendiary shells, which, when it drops into the water, ignites, and causes a thick volume of black smoke to arise, and this would accurately indicate the range. I volunteered to pay the cost of the experiment some months ago, and will cheerfully do the same now.—J. M.

if the charge was double the length, we should, of course, have double the time. We know that the powder, if ignited at the end, would be twice as long burning as when lighted in the centre. I therefore take advantage, as far as it is possible, of the shape of the chamber, to ignite it in the shortest space of time. My friend, Mr. Macintosh, alludes to the compression of the charge. I do not intend to press it hard at all into a bag, but it contains easily the amount of powder that I use. With a shot of 3 lbs., the powder will be $1\frac{1}{2}$ lbs. I know of no quicker way, unless the chamber were entirely globular, which, of course, could not be mechanically fitted into any gun.

The CHAIRMAN : I think I shall interpret your wishes if I thank Mr. Macomber for the exceedingly interesting information he has given us with regard to this very remarkable invention. I must certainly express my great admiration of it, and the way in which he has brought it before us. I think I may say also, that we desire that he should have every facility given him in this country for making known to the public the very ingenious arm that he has added to our implements of warfare.

LECTURE.

Friday, February 26, 1875.

MAJOR-GENERAL SIR H. DRURY HARNES, K.C.B., R.E.,
in the Chair.

A WARNING VOICE FROM THE SPANISH ARMADA.

By Major-General T. B. COLLINSON, R.E.

Attend, all ye who list to hear our noble England's praise ;
I sing of the thrice famous deeds she wrought in ancient days,
When that great fleet, invincible, against her bore in vain,
The richest spoils of Mexico, the stoutest hearts of Spain.

—Macaulay.

INTRODUCTION.

"Before one talks of military affairs he must first of all be skilled in naval tactics."

UPON a tablet in a public garden at Nan Changfu (the capital of Kiang-se), the above is recorded as a remarkable saying of Chang-king, who was a General in the time of the Sung dynasty.

If this maxim was considered worthy of such record in a continental empire like China, it should be of greater value in a maritime empire like Great Britain. If it signifies that the general organisation of a force at sea for battle, should form the foundation of that of a force on land, then I think it is a maxim peculiarly applicable to this country ; and that the story of the Spanish Armada of 1588, is a decided illustration of its truth.

The commonly received idea of the defeat of that Armada is that it was mainly the work of the storms of Heaven ; but those who read the accounts of it in Froude, in Mottley, and in the original documents of the time, will, I think, come to the conclusion, that although the complete destruction was caused by extraordinary tempests, yet the failure had occurred before they began, and that was due partly to the inherent defects in the Armada itself, but chiefly to the skill and spirit of the English Navy. And from the proceedings of both the contending parties, from the successful and the defective measures on both sides, I draw the same lessons, which even at this distance of time, are, it seems to me, of value, in considering the subject of the general defence of these islands ; and which will, I think, give a pregnant meaning to the maxim of the Chinese General. It appears to me that :

There are three Lessons to be learnt from the Armada.

1st. *Decentralisation.*—That is to say that as much liberty of action both in carrying out the details of preparation, and in the actual war-

fare, should be given to the local Commanders, as is possibly compatible with the control and supervision of the central authority.

2nd. *The preservation of the Martial Discipline of the Country.*—That is to say, that the defence of these islands shall be made to be felt such a national duty, that there shall always be ensured a sufficient proportion of the able population, to some extent armed, trained, and disciplined. And—

3rd. *An abundant supply of efficient Seamen.*—That is to say, that not only should there be effective seamen enough in the Navy and its immediate reserves, but that measures should be taken by the Government to preserve as far as a Government can, a race of thorough sailors in our seafaring population.

It may be said by some objectors, that one need not go back to the times of the Spanish Armada to learn that those three points are important to the defence of this country. And by others, that the days of danger to this country from great Armadas are gone bye, never to return; and therefore that the ideas of those days are no longer applicable.

I should be very glad indeed were it unnecessary for any person to appear in this Institution to call attention to the importance of those or any points connected with the defence of the country; but when one sees that, notwithstanding the vast sums expended on our Army and Navy, economy and not efficiency has been the guiding rule; and that any organisation of the population of the country towards its defence by land or by sea, has been looked upon as an obsolete idea of a passed epoch, one cannot think that these points have been as yet felt by the Government and the country to be of that importance. And hence, I hope, it will be not altogether a superfluous or useless undertaking, to draw attention to a remarkable illustration of their value, in one of the most vital exigencies of our national history.

Those objectors, who think that the probability of a great national struggle is a chimæra existing only in the brains of retired Admirals and Generals, I request to compare the present state of Europe with that immediately preceding the Armada. Then two or three powerful nations had been fighting for some years for rectification of boundary lines; large Armies and Fleets, armed with newly invented cannon and firearms, were to be found in the three great continental states. But the Government of England considered that her insular position and isolated policy rendered any serious measures unnecessary for her security. There were indeed two little clouds appearing on the horizon; one was a religious war, and the other was the fear of the great maritime power of the day that her sea commerce would be interfered with. The English diplomatists however felt certain that both could be dispersed by a judicious policy of non-interference; and they continued in that placid hallucination until the storm burst upon them. There is a large number of people in England now, who trust to ward off all dangers by the same policy, and who, if they should come, will trust rather, as Queen Elizabeth did, to the general spirit of the people, or even to a contrary wind, than pay a reasonable insurance for the existence of their country.

To my mind, the words addressed to Queen Elizabeth by some learned poet at the time are still applicable :—

"And now O Queene, above all others blest,
For whom both windes and waves are prest to fight,
So rule your owne, so succour friends opprest.
(As far from pride as ready to do right)
That England you, you England long enjoy,
No lesse your friends delight, then foes annoy."

The Position and Power of Spain.

Spain was at the height of that power in Europe, which she so suddenly and in some respects, accidentally acquired. It is no discredit to the Spanish renown, to speak of it as partly accidental; for, although the surprising conquests in America were due to the energy, and chivalry of her people, still those conquests would not have placed Spain in such a dominant position in Europe, if her sovereign had not happened about that time to succeed by inheritance to dominions in Germany, the Netherlands, Italy and Portugal.

Thus Spain seemed to have been placed by Providence in the position to reap the first fruits of the newly discovered ocean traffic; with a seaboard in the Mediterranean as well as the Atlantic, she was able to avail herself of the nautical skill of the Italian and Portuguese, and at the same time to apply the wealth and power resulting from the new world, over her dominions in the old.

Philip had acquired the dominion of Portugal, at the very time when it was most advantageous to him to use its maritime energies towards getting the dominion of the seas; he had added to his inheritances in Naples and Milan, and had thus the benefit of the talent, civilisation and naval science of the Italians. His inherited provinces in the Netherlands contained the most energetic, enterprising and advanced people of the time; but the power they thus possessed was at this time rather a disadvantage than an acquisition to him, for their rebellion had commenced, and to keep it in check occupied a great part of his forces and wealth. Nevertheless the possession was a great advantage to him as far as his affairs with England were concerned, because it gave him a position on the coast immediately opposite the most vulnerable part of England, and an excuse for collecting war forces there, without openly threatening that country.

The Spanish People.

But the marrow of his strength were his own people of Spain. They were still apparently the most warlike and chivalrous people in Europe, and still retained much of the high spirit which had marked them at one time as the most independent of the Gothic races. The result of the long wars with the Saracens, and the subsequent wars going on up to that time in Italy and the Netherlands, had established the Spanish Infantry in the position once held by the archers of England, in Europe: and this superiority was strengthened at that time, by their being more generally armed with the new fire-arms,

than the infantry of other countries. The remarkable religious fervour of the people, though it injured their power as a nation, gave force to them as soldiers. And this great element of strength, was not, as in most other European countries, a merely latent power to be called forth on special emergencies under the feudal regulations, but in Spain it was a fully organised power, and always kept in a condition ready for action. By the help of the wealth from the Indies and from the continuous warfare in his provinces, the King of Spain was able to keep up a force of trained and experienced soldiers, accustomed to traverse Europe and to fight in any country.

The maritime power of the country had culminated in the victory at Lepanto, 17 years before; since that time Spain had been acknowledged mistress of the seas. But there was an element of weakness in it, which caused its speedy fall. It was a seamanship based on the traditions of the Mediterranean and on the navigation of a comparatively safe coasting trade; and unfit to cope in the open ocean with that of the more daring and skilful seamen, trained in the boisterous seas of the North. The very fact of their predominance, led their ocean navigation to take the form of trading with their wealthy Indian dominions, rather than for war or stormy seas.

The internal condition of Spain was favourable to her power in Europe. The peace since the wars with the Saracens, and the commerce and consequent wealth that flowed in from the immense possessions of Spain and Portugal in the East and West Indies, had improved the conditions of the people; and yet the power of the sovereign over the people and resources of the country had become almost absolute. The population of Spain itself was about 7,000,000, or nearly half what it is at present, and the physical condition of the people was probably better. The population of the other European countries under Philip's rule, must have been greater in proportion, because they were then the most advanced countries in Europe; taking them at half their present numbers, Portugal, Naples, Milan, and the Netherlands south of the Scheldt (which was still under Spain), would have contained altogether about 8,000,000.

Thus the King of Spain had supreme power over the finest parts of Europe, containing a greater population than any other kingdom, and those in the most advanced condition of any people of the time; he had also absolute control over greater wealth than any other sovereign, and the largest and finest military force in Europe, and a navy then considered supreme on the seas. No King since him, not even Napoleon, has held such a dominant power in the western world.

That naval supremacy fell, partly because it was accidental to the time, and partly because ocean traffic opened a way for new powers to arise. And the fear of being interfered with and perhaps altogether supplanted in his monopoly of the rich traffic to the East and West Indies, by the bold and skilful seamen of England, was no doubt the mainspring of Philip's determination to invade that country; the reasons ostensibly given, Religion, and the outrages of the English privateers on Spanish property, were sufficient to give a legal colour to it, in the state Europe was in at the time.

The Power of England.

Compared with Spain, England was then, as Mottley says, not more important in Europe than a province of King Philip's extensive dominions. The population of England and Wales was something over 4,000,000, or about one-fifth of the present population, and nearly that of Belgium in 1866. Scotland was still a foreign power, and at that particular time in a state of such doubtful alliance, as to be a subject of anxiety, not of assistance. Ireland was in open rebellion, supported by Spanish help, and therefore occupying the attention of part of the military forces of England, just as the Netherlands was doing to those of Spain.

The internal condition of England was, however, better than it ever had been before. There had been one hundred years of peace in the land, and under the strong but popular rule of the Tudor Sovereigns, the material prosperity of the people had increased, notwithstanding their religious difficulties. The English mariners, who had been rather repressed during the middle ages, soon began to take advantage of the use of the compass, and in ocean discoveries and ocean traffic, found a field for their reviving energies. Still, it was but a small affair compared with the immense traffic of Spain, or even with the advanced condition of the Netherlands. The great exports at that time were wool and corn. The export of wool to the Netherlands in 1550 was valued at about £1,000,000 per annum: not nearly so much in proportion to population, as the present export of cotton goods to India, and probably the whole exports may be taken at £3,000,000 per annum, which, taking the purchasing power of money to be nine times as much in 1550 as it is now, would be £27,000,000 in this day, or £5 or £6 per head of the then population. There was such a mutually advantageous inter-trade between England and the Spanish peninsula, that it delayed open war between the two countries; but it did not affect the ultimate determinations on either side; these were settled by considerations of religious conviction and political ambition.

The war forces of England were in a worse condition than they ever had been. As there was no army but that of the old feudal regulations, the long peace had led to a neglect of military exercises; not only was the renowned weapon of old England, the bow, dying out, but the new weapon, the fire-arm, was little known from want of war experience. Englishmen had evidently begun to think, as many do now, that war, international war, was as much a thing of the past, as domestic war had been for so long. The English infantry had appeared very little on the battle fields of Europe during the disputes between the great continental nations; and when they did appear, it was in a sorry plight, and, with some brilliant exceptions, to little advantage. The Navy had been neglected during the short reigns of Edward VI and Mary; and it was owing to the opening for sea traffic, that the spirit of English seamanship was preserved to such an extent, that when the occasion came, it alone was prepared to meet the enemy. It is true that Elizabeth, from the beginning of her reign, paid atten-

tion to the defences of the country, but as she was naturally too niggardly to spend boldly, and too proud to call in her Commons to do the work, both the naval and military forces of the country were in a somewhat similar condition to that they were in our own day not many years ago.

"And yet," says Mottley, "the little nation of four millions went forward to the death grapple with its gigantic antagonist as cheerfully as to a long-expected holiday. Spain was a vast empire, overshadowing the world; England in comparison, but a province; yet nothing could surpass the steadiness with which the conflict was awaited."

The English People.

This was owing mainly to two elements of strength which then existed in England, the powers of which were not fully appreciated by Philip, or by any of the continental nations, at the time. These were the *physical and political condition of the people, and the seafaring ability*; and the circumstances of them are worthy of the attention of statesmen at the present day.

In comparing the powers of two nations for conflict, there are two elements of strength to be considered—wealth and population. The measure of wealth, for all ordinary cases of war, may be taken to be the annual produce of the country in agriculture, mines, and manufactures; and in extreme cases it would include every kind of property in the country that has a saleable value. In this respect, taking into consideration all Philip's dominions, European and Colonial, Spain was to England then, very much what England is to Spain now.

But in comparing two populations, not only their numbers must be considered, but their physical, moral, and intellectual condition. The actual physical condition of two peoples may be fairly measured by the respective consumptions of nourishing food; and in this respect the people of England were then superior, perhaps to all other European peoples. Dr. Lyon Playfair has stated that the amount of useful mechanical work stored up in a man, is proportional chiefly to the amount of flesh-forming food he consumes, and from experimental examples of various diets, he considers that 6·5 ounces per day of flesh forming matter, is necessary for a hard-working labourer. Then Dr. Lankester states that the best flesh-forming substance for man to eat is meat, of which matter it contains about 22 per cent.; hence, if the whole of the 6·5 ounces were to be obtained from meat, the hard-working labourer would require 2 lbs. daily. Now, in the sixteenth century, meat was about one-fifteenth of the price it is now. In the reign of Henry VIII, an Act of Parliament, fixing the price of beef at $\frac{1}{2}$ d. a lb., was considered oppressive on the poor. This was owing to the large proportion of the soil of England which was then under natural herbage. But to judge fully of the effect, we must consider the rate of wages; and this consideration is facilitated by the circumstances that the pound in Queen Elizabeth's time, was intrinsically of the same value as it is now. So that if we determine how much food a labourer could purchase in those days, we shall have some sort of

measure of his physical strength, as compared both with other nations of that day and with the labourer of the present day. The average daily wage of a labourer in the early part of the sixteenth century, was $3\frac{1}{2}d.$ throughout the year: taking meat at $\frac{3}{4}d.$ a lb. and bread at $\frac{1}{2}d.$ a lb. (wheat being on the average at that time $6s. 8d.$ a quarter) and beer at $1d.$ a gallon; he could purchase 2 lbs. of meat, 2 lbs. of bread, and a gallon of beer. To purchase the same amounts in the present day would cost the labourer about $2s. 10d.$ Thus, in respect of the essential supports of physical strength, the labourer in Queen Elizabeth's time was better off than he is in the days of Queen Victoria.

That this was felt at the time to be a peculiarity of the English people, although its full value was not recognised, was shown in various ways. A State Paper of 1515 says, "what comyn folk in all this world may compare with the comyns of England in riches, freedom, liberty, welfare, and all prosperity." A writer in England in 1577 says, "These English have their houses made of sticks and dirt, but they fare commonly so well as the King." And one or two others, natives and foreigners, remark on the good feeding of the English, which enabled them to bear arms and fatigue better than the soldiers of any other nation. And the pay and rations of soldiers and sailors was in proportion. Before the time of the Armada, a seaman in the Royal Navy, received $6s. 8d.$ a month, and a daily ration besides of 2 lbs. of meat, $1\frac{1}{2}$ lb. of bread, and 1 gallon of beer; being a good deal more than he gets at present, considering the different value of money. The Militiaman cannot be compared with the soldier of these days, because he only got paid when out for exercise; but then he received (1588) $8d.$ a day, equivalent now probably to 4 shillings, or the following extraordinary ration, $2\frac{1}{2}$ lbs. beef, $1\frac{1}{2}$ lbs. bread, 2 quarts of beer, 1 quart of wine, $\frac{1}{2}$ lb. butter, 1 lb. cheese, 1 lb. biscuit!

There is no soldier or sailor in any Army or Navy in Europe, and no labourer in England, except perhaps the navy, who is fed up to what Dr. Playfair would call such a "war pitch," as was the labourer in the sixteenth century.

The English Political State.

This quality, however, would not have enabled the English to defeat the Armada, if it had not been accompanied by moral, intellectual, and political advantages, which were also peculiar to this country. The whole nation was then organised into one complete body politic, and the people, though technically divided into Catholic and Protestant, had throughout, a deep religious feeling, and a strong sense of their duty to God and their country. Froude says, "The Legislature undertook to distribute the various functions of society by the rule of capacity; of compelling every man to do his duty—securing to him that he shall not be injured by his neighbour's misdoings." Under this system, every man was brought up with the idea that it was his duty to be trained as a soldier to defend his country, as well as in some civil capacity to serve it; and the object of the statesman was

not to increase the wealth of the country by the encouragement of commerce, but the maintenance of the population then existing in a sound and healthy condition of body and mind. The organization of the population was as complete as that of Prussia is now, only it was not as an army for offensive purposes, but as a nation, for religious, civil, and defensive purposes.

Every class in the State was taught that they had duties as well as rights; and as the labourer was so plentifully supplied with food, and having a somewhat independent position from the possession of a few acres of land, which he had by law, he was in a condition to appreciate and perform his part in the State, and ready for hard work and enterprise. England, moreover, was altogether in a better condition than other countries to take advantage of the revival of learning, and also of the new opening for enterprise in the oceans and worlds not long discovered, and now being opened out.

The seamen were good specimens of these characteristic qualities of Englishmen at that time; they are called by Mr. Kingsley, the true descendants of their Viking ancestors; their boldness was that of independent reasonable men, who felt that they had a responsibility in the face of difficulty, and that they had the skill and the power to meet it.

It appears from the foregoing that the power of Great Britain now, in respect of a conflict with another nation, is at least sixteen times as great as it was then. The population is eight times as large, and the exports of the country, which may be taken as some measure of the wealth, are now nearly £10 per head, whereas in those days they were apparently only £5 or £6 per head.

PREPARATIONS IN SPAIN.

In the huge isolated palace of the Escorial, by himself at his study table, sits a grey-headed man of sixty, who, from his slight frame and stooping posture, and assiduity to his desk, might have been taken by a stranger for a confidential clerk of the palace. This is Philip II, King of Spain, and ruler of Portugal and parts of Italy, Germany, and the Netherlands, and of both the Indies; who sits here for hours together, day after day, seeing few people, saying little, trusting nobody, but directing the affairs of his vast empire himself, and sowing discord all over Europe by the correspondence dictated in that room.

It is a picture worthy of the attention of all Englishmen, for in that room was hatched the invincible Armada, and those very circumstances of its birth were some of the principal causes of its failure. Philip himself gives to the Duke of Parma, his Viceroy in the Netherlands, the credit of originating the idea of an invasion of England, by way of putting an end completely to the Protestant ascendancy in the north; but Philip himself is responsible for the plan of carrying it into execution. It was he who decided that while Parma was preparing troops and means of landing and occupying the country, the fleet that was to protect his passage should be prepared in Spain; and, although Parma was to be the supreme chief of the undertaking, the person command-

ing the fleet was of such rank that he was, in effect, an independent authority. Then, again, Philip ignored the advice of Parma that a proper harbour in the Netherlands, for embarking his troops and to which the fleet could get access, should first be secured; and thus it happened that, when the fleet arrived at their appointed place, selected by Philip, Parma could not bring his troops to them, and the fleet could not reach him without first defeating both the English and the Dutch fleets. Then, the jealousy of the two great Commanders made them each suspicious of the other, under the action of which the fleet left the rendezvous, and never returned.

The habit of secrecy and mistrust, characteristic of Philip II, prevented him from confiding, to any person but the Duke of Parma, the destination of the great expedition he had ordered to be prepared; and he had not the capacity himself to organize the details absolutely necessary for the work to be done. The result was that ships were constructed unfitted to fight those of the enemy they were to meet; proper information was not obtained of the countries they were going to, or proper pilots for the coast; no arrangements were made for insuring the junction of the two parts of the expedition; and, at the last moment, a wealthy nobleman, who had been a soldier, was put in command of an expedition expressly naval. It would probably have given more chance of success if Philip had published his purpose to all the world, as he would then have been compelled by his advisers in Spain to listen to the repeated warnings of Parma. He did succeed in blinding, to some extent, the Governments of Europe, and especially that of the country he had in view—England; but, fortunately for us, he could not altogether lull the feelings of the people of this country, and especially of the seamen. And it may be said to be owing to his boast that he governed the world in secret from his room in the Escorial, that the Armada had in itself causes almost sufficient for its failure.

The actual preparations were probably begun in 1585, when the direct assistance given by Queen Elizabeth to the revolted Netherlands showed Philip the necessity for taking more decided measures against England. But his slow methodical ways of carrying on all the services of his empire, which he had concentrated in his own hands, extended to the Armada, and it was not ready till May, 1588, when it actually started. Thus, again, by his own fault, he lost the opportunity of taking England unprepared. And yet so little did he realise the character of the business he had taken in hand that, when he found the time going by and the preparations in Spain still behind-hand, he proposed to the Duke of Parma that he should invade England without waiting for the Armada from Spain, forgetting that it was by his own direction that no war-ships had been provided in the Netherlands' part of the expedition, because the Armada was expressly to convoy Parma's forces over.

The King had a large area from which to draw his resources for the equipment of the expedition. Besides the ports of Spain proper, he had the more efficient ones of Portugal, and those of the adventurous Biscayans, and of the more advanced and scientific Italians. The harbours of all these countries were occupied during those three years with the

preparations for the contingents they were to supply towards the great Armada; and from all these countries bodies of horse and foot soldiers were making their way, either to Spain or to the Netherlands, to form part of the invading army. The power of the King was absolute, and the work was blessed by the Pope; for, although the precise destination was not allowed by Philip to transpire, it was well known that, at all events, it was to be employed in the service of the Catholic Church against the heretics. And yet, notwithstanding these powerful influences, it was not till the beginning of May, 1588, that the whole force was assembled in the Tagus, ready to start. And before that time, another act of Philip's had struck a heavy blow against the prospects of the expedition. The first commander appointed to it was the Marquis of Santa Cruz, a man of considerable naval experience; under his superintendence the preparations were made, and under his guidance it might have had a different issue. But the ignoble spirit of the King was influenced by other favourites to discredit this naval noble, and in so evil-minded a manner that the Marquis died of chagrin three months before the Armada sailed. Then, to complete his mistake, he appointed to the command, the Duke of Medina Sidonia, whose capacity for it, as compared to the other, was marked by the saying that "to the iron Marquis succeeded a golden Duke." He was a grandee of vast wealth, with little capacity, and less experience.

List of the Spanish Armada that sailed from Lisbon at the end of May, 1588.

Commanded by—

The Portuguese squadron..		The Duke of Medina Sidonia..		12 vessels of various kinds.	
"	Castile	"	{ General Diego Florez de Valdez (the most experienced sailor in the fleet) ..	16	do.
"	Andalusian	"	.. General Pedro de Valdez	11	do.
"	Biscayan	"	{ General I. M. de Recalde (the upper Admiral)	14	do.
"	Guipuzcoan	"	.. General Miguel de Oquendo..	14	do.
"	Italian	"	.. General M. de Bertendona ..	10	do.
"	Urcas	"	{ General Gomez de Medina (store ships)	23	do.
Tenders, caravels, &c.		General A. H. de Mendoza ..		22	do.
The galleasses of Naples....		Don H. de Moncada		4	
The galeras, or galleys		Captain D. Medrado		4	

The second in command was Don Al. de Leyva, and Don Fr. de Bobadilla and Don D. de Pimentel were chief officers.

The total number of vessels given by Don D. de Pimentel was altogether 145, of which 110 were men-of-war, and 90 very large.

The total tonnage of the whole fleet was		59,120	} By Mottley, on the authority of Spanish writers.
"	number of guns	3,165	
"	" soldiers	19,265	
"	" mariners	8,252	
"	" galley slaves	2,088	

Don D. de Pimentel said that daily allowances were issued for 32,000 people.

The size of the men-of-war varied from 300 to 1,200 tons. Pimentel's own ship (a galeass of Portugal) was 700 tons.

The galleons were huge, clumsy vessels, with round sterns, built up at stem and stern like castles, and with bulwarks musquet proof, and the lower work four or five feet thick, which was proof against small guns.

The galleys were rowed by slaves, who sat amidships; the bow and stern had each enormous towering structures, like castles. The cannons were placed both in these and between the benches of the slaves.

The galeasses were similar, but one-third larger; each of these was rowed by 300 slaves.

Pinaces and caravels were small sailing vessels, about the size of modern yachts.

All the vessels were over-weighted with top hamper in proportion to their draught, and could bear but little canvas, even in fine weather.

A large vessel carried 63 guns; Pimentel's carried 32; but one-third of the guns were of cast-iron. There were at least 40 rounds of ammunition per gun.

The Spanish soldiers on board the Armada contained the picked veterans of Spain, and were considered to be the pith of the whole expedition.

The Armada was said to be provisioned for six months. A Spanish record made by order of King Philip, gives the following list of provisions on board:—

110,000 quintals of biscuit.		
6,500	"	bacon.
3,458	"	goats' cheese.
8,000	"	fish.
3,000	"	rice.
6,320	sepiers	of beans or white peas (of 1½ bushel each).
14,170	pipes	of wine (of 110 gallons).
11,398	arrobas	of olive oil,
33,870	arrobas	of vinegar,
11,875	pipes	of water.

} The quintal being
101½ lbs.
avoirdupois.

} of 3½ gallons each.

which would be a poor provision for 30,000 people for six months. It gives, however, some notion of the difference in feeding of the Spaniard and the Englishman of that time.

The same authority gives the following arms on board:—7,000 arquebusses, 1,000 musquets, 10,000 pikes, 1,000 partisans, 6,000 half-pikes, so that the proportion of fire-arms to soldiers was nearly one-half; a greater proportion than in the English forces; and the Spaniards had, no doubt, better fire-arms, and were more practised in their use.

Construction of Spanish Ships.

Sir W. Monson, an Admiral of those days and a great naval critic, had not a high opinion of the Spanish navy. He says their vessels were generally constructed for commerce rather than war; that they were commanded by soldiers who were ignorant of the sea and despised the real seamen; that Philip had to get ships and seamen from other parts of his dominions than Spain; the good vessels in the Armada

being other than Spanish; and that generally the English were at that time superior to the Spanish at sea; but this was owing, not to the construction of the ships, but to "the irresolution and insufficiency of the men." One is rather surprised to hear this of the conquerors of the New World and rulers of an empire on which the sun never set, but we must recollect that it was the Portuguese who first led the way in maritime discovery, and that Philip had the control over the naval resources of Portugal, which he used for the Armada to an extent disastrous to that country.

Sir William enters into the discussion of construction of vessels with a zeal that would have given him a prominent place in naval literature had he lived in the days of ironclads. He does not coincide in the opinion we find expressed by other sea captains of the time, of the advantage of the small handy English ships; for, as he puts it, in a maxim worthy to be handed down by English sailors, "when you speak of the strength of ships, you must speak of the sufficiency of the men within her." Sufficiency, not of quantity, but of quality. Therefore, he says, "I would rather desire a reasonable ship of the King of Spain's manned with Englishmen, than a very good ship of Her Majesty's manned with Spaniards." In short, he leads us to infer that, in his opinion, the Spanish Armada was defeated, not by superiority of ships, but of seamen; a view of naval warfare which, in these days of scientific naval construction, ought not to be obscured. Indeed, he commends the galleys, vessels which failed beyond all in the Armada, and especially the "gallias of Venice," as "low and snug by the water," "carrying the force of a ship in men and ordnance;"—"not swift, but certain"—in fact, the "Devastation" of her day. Thus we learn, from the criticisms of this expert of the time, that, although the size and construction of ships may alter from age to age, the different classes of them necessary for naval war will remain much the same throughout all ages, and the main naval strength of a country will always depend on the quality of the seamen.

Preparations in the Netherlands.

The Duke of Parma, King Philip's Viceroy in that part of the Netherlands which still acknowledged his rule, was considered one of the best soldiers of his day, and was, besides, an able ruler and diplomatist. If Philip had put the whole affair of the invasion of England into his hands, the issue might have been very different; but, fortunately for this country, Philip's habitual distrust made him limit Parma's action to the preparation of the main body of the land forces required, and Parma appears to have done his part with completeness, zeal, and caution. For he had his forces fully equipped for their work long before the Armada was ready; and during the whole time the preparations were going on, he succeeded in so blinding Queen Elizabeth and her councillors, that negotiations for peace were carried on up to the last minute; and one of her Commissioners in the Netherlands writes confidently of Parma's pacific intentions on the day when the Armada was having its first engagement with the English fleet.

By April, 1588, Parma had collected, under pretence of subduing the newly united Provinces, and of checking France, a force of the following composition and numbers :—

<i>Infantry.</i> —Spanish	8,718
Italian	5,339
Burgundian, Irish, and Scotch	3,278
Walloon	17,825
German.....	19,925
Garrisons of fortresses.....	1,180
	<hr/>
	56,265
<i>Cavalry.</i> —German.....	3,650
Foreign mercenaries	668
	<hr/>
Total.....	60,583

Of this total force, it was expected that about 30,000 would be available for the invasion of England; and this 30,000 had dwindled down to 16,000 by August from sickness and other causes.

These were collected from all the dominions of Philip, and contained many experienced and celebrated bodies of troops. There was the Terzio or Legion of Naples, 3,500 strong, every man in which had armour either inlaid or gilded; and the young adventurers, Catholic nobles of Europe, flocked to the Netherlands to serve under so distinguished a leader on so important an expedition. He had already prepared, during the year 1587, a large stock of war material suitable for the undertaking: rafts and oars for landing, fascines and sand-bags to form temporary shelter at first, timber for stockading quickly the posts occupied, barrels and superstructure for temporary bridges, special carriages for quickly getting his field guns up on landing; and he had built, or purchased from the North German ports, 400 vessels, which he describes as mere transports, many of them flat-bottomed, and incapable of making any fight at sea; although both Philip and the English appear to have thought he had an independent war fleet, and, by acting on that belief, caused difficulties on both sides.

Parma had desired to obtain possession of Flushing beforehand, a deep water harbour, into which the Armada could have entered, but as he could not make his master understand the absolute necessity of having such a harbour to effect the junction of the two parts of the expedition, and as Philip was earnestly pressing him to be ready, as the Armada would join him in the autumn of 1587, he had to content himself with taking Sluys, which he was able to effect, owing chiefly to the supineness of Elizabeth, who would not expend money towards its defence. Thus he had three small harbours, Sluys, Newport, and Dunkirk, for embarking his forces; and he made a canal from Sas de Gand to Sluys for his transport vessels, as the ordinary channels were in possession of the United Provinces. But these three harbours were inaccessible to the large vessels of the Armada, and as they were carefully watched by the Dutch fleet, he and his elaborate preparations were unavailable until the Armada could clear the seas of

the two hostile fleets. Parma excuses himself from blame in this matter by reminding Philip that he was expressly instructed to depend on the Armada for securing his passage across; that alone would hardly be sufficient explanation to clear so powerful a Viceroy; but he also complains of deficiency of the money promised for these objects—a deficiency which was probably caused by Walsingham's financial manœuvres on the Bank of Genoa, as related by Burnet.

Cost of Spanish Preparations.

The cost of the whole of the Duke of Parma's force, military and naval together, is recorded as 454,315 dollars per month, or, taking the dollar at 4s. 2d., it was £94,649 per month. The cost of the naval part of the Armada itself is recorded as 12,000 ducats per day, which, taking the ducat at 5s. 2d., would be £93,600 per month; and the cost of the whole expedition, including both that from Spain and that in the Netherlands, is recorded as 30,000 ducats per day, or £234,000 per month. Froude says, the total cost of the Armada was expected, in 1585, to be 4,000,000 of gold crowns, which, at 5s. 2d., would be about £1,000,000 at that time. There must be some mistake in this, because, in 1587, Philip told Parma he had 6,800,000 ducats ready for the expense of it, which would then have been upwards of £1,500,000.

Thus one can see that there was an element of failure in the Armada itself. But, besides that defect, it was not so very powerful an expedition, considering the resources of King Philip, at least, compared with armaments of our time. Taking the population as a standard, and assuming the population under the control of Philip for these objects, at 15,000,000, the total tonnage of the Armada gives one ton for every 250 persons, which we shall find was much less in proportion to population than what was provided in England to meet it, and is less than the tonnage of the ironclad fleet of France in proportion to its present population. The total number of persons engaged both in Spain and in the Netherlands, bears about the same proportion to population as the army for the invasion of England prepared by Napoleon in 1803; and in each case it may be assumed that the full power of the invading country was put forth. Then again, although the tonnage of the Spanish fleet was much larger than that of the English, the Spanish ships carried fewer sailors per ship, and had on the average 200 persons per ship on board, so that they were transports as well as fighting ships, and with less manœuvring power.

Nevertheless, it was acknowledged by all Europe to be a splendidly appointed and very powerful expedition; and the forces themselves looked upon success, not only as certain, but easy. If religious enthusiasm, chivalrous spirit, and military skill could ensure success, they had reason to be confident; for the expedition contained the choicest of that Spanish race which had so distinguished itself in the world, from the noble to the veteran soldier; and there is no doubt that they were animated with a sincere belief that their cause was approved by Heaven. The experienced seamen among them had, however, already felt that the English seamen were more than a match for

them at sea; and the whole Armada had to acknowledge, in the end, with the bitter disappointment of brave men, that success on the ocean belongs to those who are born to the sea.

PREPARATIONS IN ENGLAND.

When we turn to the preparations made in England to resist this great expedition, we find a remarkable contrast, both in the matter of the preparations made, and in the manner of making them, which illustrates the genius of the two nations, as well as the character of their rulers. We find a Sovereign desirous of peace, and parsimonious, but forced into a great war by the bold determination of her people. It is an instructive example to the rulers of Great Britain for all time, of those eventful periods which have occurred sometimes in our history, when the sound instincts of the people have risen to direct their reluctant governors in the right path of England's duty.

Queen Elizabeth, with all her intellect and high courage, and loyalty to her faith and country, inherited the despotic feeling of her family, and added to it a closeness of her own, and a womanly attraction towards peace. Her arbitrary aversion to appeal to her Commons, and her remarkable repugnance to spend money, nearly counteracted all the efforts of the country. The contest was virtually between Philip and all England; and the monarch discovered the mistake, as others greater than he have done, in backing himself against such a field.

The one remarkable, and encouraging and instructive feature about the preparations in England was their *complete localisation, both materially and in spirit*. No doubt this was fostered (as Mr. Mottley says) by the two new passions that had taken hold of the English mind, revolution against the Pope and mercantile adventure, which were now combined with the old martial spirit of the people. The first feeling had been used as an incentive against Spain, for three years before the Armada, from the pulpits of the Church; that is about the same time that the Queen determined to give material support to the Protestants in the Netherlands. The second was kindled into new life by the opening of the splendid traffic of America, and necessarily the old seafaring spirit of the Northmen was both roused and made antagonistic to the Spanish claims in those countries. Thus the people of England were quite prepared in spirit to take up any gage of battle thrown down by Philip.

But though this localisation affords us so useful a lesson in some respects, it must not be forgotten that it nearly failed in saving the country, and that the cause of its want of efficiency was the absence of that very central motive power which was so injurious in Spain. The one part of England's defence which was successful, the Navy, owed it to that unity of authority combined with individual enterprise, without which it could hardly have existed at all. Thus we learn, that as in each country the system of national defence must be suited to the national characteristics of the people, so in England no system will be thoroughly national and thoroughly effective which does not combine a powerful central direction, with local liberty of execution.

Without the latter, the true spirit of the English people will not be roused; without the former, that spirit will be of little value against an enemy.

Queen Elizabeth acted in a perfectly legitimate manner in calling upon the counties to raise and organise their quotas of armed men for internal defence, indeed, she had no other means of raising any land forces. The old feudal duties of subjects had not then expired, though they had been modified (to meet the altered state of the country after a long peace) by the allowance of substitutes or money payment instead of personal service. In Elizabeth's reign this feudal duty was organised by counties, and the Lord-Lieutenants of counties were made the Queen's representatives for seeing the order properly carried out; each county was subdivided among Deputy Lieutenants, also appointed by the Queen, and under them were captains of horse and of Foot, who were generally officers who had served in foreign wars. The quota of horse and foot to be furnished by each county is given in the State Papers, and even that of certain individuals, justices of the peace, bishops, and others. They were all to be furnished, clothed, armed, victualled, lodged, and munitioned, at the expense of the county for a certain time after enrolment, after which, if kept embodied, it was at the Queen's expense. This was a happy arrangement for the great, but penurious Queen, but a very unfortunate one for the necessities of the country; for the Queen took care that they should never be in training long enough to come under her charge, and the counties were not eager to incur the expense of the training without having the necessity strongly brought home to them.

False Economy of the Government.

Two remarkable instances of the Queen's unwillingness to incur expense in war, and to bring matters between herself and Philip to such an issue, occurred in 1585 and 1587.

In 1585, the newly-united Provinces of the Netherlands sent to offer the sovereignty of their country to Elizabeth. Notwithstanding her decided predilection for the reformed faith, and her fear of the power of Spain; and, notwithstanding the warning of some of her counsellors that, if she did not fight Philip in the Netherlands she would have to fight him in England, she not only refused the sovereignty, but snubbed the deputation, and only agreed to help them with troops on condition of her favourite Leicester being made Governor of the Netherlands and of her receiving some towns as securities. She sent over some 10,000 men, of all sorts, but as she soon ceased to pay them, they became a trouble instead of an assistance to her Dutch allies. Her repugnance to join heartily with the United Provinces was, perhaps, partly due to her tendency for diplomacy, in which, however, she was no match for the unscrupulous Philip, and his still more unscrupulous viceroy, Parma. But the mainspring of her action seems to have been fear of spending money. Secretary Walsingham says, in 1586, "rather than spend £100, she can be content to be deceived "of £5,000;" "Her Majesty and her Council do greatly stagger at

"the excessive charge;" "She scorneth the peril (of giving up the "cause of the Netherlands); the hope of peace with Spain has put her "into a most dangerous security." One cannot but think that, if she had carried on a bold war in the Netherlands, the Armada would have been forced on before its time, and England would have come out of the struggle holding a much higher place in the world.

But though the English land forces were thus losing precious time for want of resolution in the Government, the English navy, with equal spirit and more confidence in themselves, was not tied down by the same leading strings. Sea expeditions not being then considered to be actual war, and every merchant ship being prepared to fight, it had long been the custom of the adventurous sea captains to fit out expeditions, especially against Spain, partly private and partly supported by the policy of the Government. It was not, therefore, difficult for Sir Francis Drake to get up such a combined expedition to discover what the Spaniards were really doing in the matter of the Armada. For, by the spring of 1587, says Stowe, "the commonalty began to entertain a stronger opinion touching the Spaniards' settled resolution for the invasion of England than either Queen or counsel." And Drake was the popular hero of the cause, just as Nelson was afterwards against Napoleon. And good service he did. With 4 Queen's ships and 24 merchanters, he entered Cadiz harbour, silenced the forts, beat back 12 great galleys, and destroyed 10,000 tons of shipping; and repeated the performance in the Tagus, under the eyes of the Marquis of Santa Croce. By which performances he not only delayed the Armada for another year, but produced the more important effect in war of shaking the *morale* of the enemy, and "taught the mariners of "England how to handle those great galleys," but, though Lord Burghley himself gives this testimony to Drake's exploits, he is obliged to add, "Her Majesty is greatly offended with him." The attacking Spain itself was carrying the little game at sea rather too far for her cautious policy; she sent an express after him to forbid it, but fortunately for all parties, there were no electric telegraphs between London and Plymouth in those days, and she was enabled to make political capital out of her attempt, and at the same time reap the benefit of Drake's misdemeanours.

Detail in Counties.

The preparations on land for defence were extremely well elaborated on paper. There were to be three distinct armies, and a reserve; forming, one may say, three lines of defence. The first line, that "to "encounter the enemy on his descent," was to consist of 34,262 men, spread along the south and east coast, and to be furnished by the counties bordering on that coast. The second line was to consist of 22,872, stationed at Tilbury, because it was expected that the descent would be made in Kent or Essex, and was to be furnished from the midland and southern counties. The third line was to consist of 28,900, and be stationed near London, and considered as the Queen's guard, and was to be furnished by selected troops from all the counties. The reserve, 46,145, was to remain in the counties, to be used as required. These make a total of 132,179; but, in addition to them,

there were the quotas to be raised in Wales, amounting to 9,377, which are not included in any of the above; also, those in Yorkshire and Durham, which formed a separate command of about 14,000 and then there are nine northern counties not mentioned at all, so that the total force calculated (on paper) to be raised in all England and Wales must have been nearly 170,000.

The great principle at the bottom of all these proceedings was, that every man in the country, if he was able, was bound to assist in the defence of it. The returns from the counties give the number of "able men" above 16 years old, and also the number "furnished" to "armed;" but these returns are evidently not trustworthy, for, on the whole, the number of able men returned is not above double that taken for service. Now, Sir W. Raleigh estimated the number of men capable of bearing arms in England, at that time, to be 1,172,000; a much more probable number when we consider that, in 1841, the male population of England, between the ages of 16 and 45, was one-fifth of the whole population.

This 170,000 would have been a respectable force in proportion to the population of about four millions, if it had actually existed and had been trained and armed; it would have been *one twenty-fifth of the whole population*. The present military forces of Great Britain, including Volunteers, are about *one sixty-fifth of the population*. The war army of North Germany, including Landwehr, is about *one thirty-fourth of the population*, but, including the Landsturm authorised in 1874, it is about *one-fifteenth of the population*. But the numbers actually embodied fell very far short of these, and the training and arming were still more lamentably deficient; and the fault that it was so, lay more with the Government than with the people.

Norfolk.

It is when we turn to the details of arrangements in each county that we see the genius of the people really appearing. As early as 1586, instructions were given to the Lieutenants of counties, but they only mentioned generally the different points that were to be considered, leaving it to the county authorities to apply them to each locality. Mr. Bruce gives, as an example, the arrangements made in the sea-coast county of Norfolk—not one of those most threatened—and which appear to have been due to Sir Thomas Leighton. Eight places on the coast, considered to be those of greatest danger "by reason of the good roads into the interior and the depth of the sea inshore," were selected to be fortified temporarily and to be the guard-posts of the forces. Two of these, Waburne and Yarmouth, were selected as the centres of defence. The whole force of the county, about 3,000 foot and 250 horse (which is about the average of each county's quota for the first line of defence) were divided into two divisions, one to each of these two places, and each of these into three or four subdivisions; so that, in each subdivision, there were about 300 foot (half of whom were "trained" and half "untrained") and 40 or 50 horse, of whom about one-fourth were "Lancers" (or regular cavalry) and the remainder "light horse," which probably meant the

yeomanry of the time. With each subdivision there were some 70 pioneers, with spades, picks, shovels, axes, bill-hooks, and "brown-bills," and a few artificers (carpenters, smiths, and wheelwrights), and two carriages.

The subdivisions were told off (by name of captain's) to take duty by the week at one or other of the above two centres (as convenient to their locality), to keep guard and go on with the defences. On an alarm (by beacon fire), each full division was to repair to its centre. The remainder of the able bodied population were to assemble at certain appointed places in their respective hundreds, and wait further orders from the Deputy Lieutenants.

If a division was driven back from the coast, the whole force was to retreat on Norwich, which was to be victualled with that intention, and Mount Surrey was to be intrenched and defended, as well as the castle, and certain named bridges, over rivers between Norfolk and the coast, were to be prepared for defence, and for destruction. On retreat from the coast, no carriages were to be left, all corn that could not be carried away was to be destroyed, and cattle driven into marshland, and the bridges on their route destroyed. The chief constables were to appoint the watchers of beacons, and watchmen at every bridge, and post-horses in continual readiness, at all needful places on the coast, to carry information; also, a foot-post in every parish, and a horse-post in every market-town. If the enemy could not be impeded from marching on London, the county force was to follow close on him, to hinder as much as possible his spreading and foraging over the country.

Arms.

The clothing was supplied by the county, and cost about fifteen shillings a head. The arms were either purchased or "requisitioned" from private individuals. It was an unfortunate period, in this respect, for England's position; the old English long-bow was giving way before the musquet, the latter not only required more skill and training, but they were more difficult and more expensive to obtain.

The advantage of a weapon like the long-bow to the English people was, that it could be used to full advantage only by a strong bold race. It was, moreover, so easily attainable in the country itself, that every labouring man could provide himself with one, and the regulations for practice throughout the country placed the means of keeping up his skill within easy reach of every man. It was no despicable weapon in the hands of well-fed Englishmen: the effective range was from 300 to 400 yards, and an arrow could be discharged every two or three minutes, with fair certainty of hitting a man at that distance; whereas the new firearm, though it carried farther, required fifteen minutes for each discharge, and was not very sure of its mark even then. The introduction of breech-loaders, also a weapon that requires bold and skilful men to bring out its qualities to full advantage, appears likely to restore to the English infantry some of that superiority which they held with the bow in the middle ages.

In Norfolk they desire, "if possible, 45 musquets for every 300

"men," and though London could muster 4,000, "chiefly shot," in other parts of the country, only about one-third of the whole force were armed with musquets, harquebuses, or calivers, the remainder were armed with bows or bills. The horsemen were so few in number (about one-fifteenth of the whole in the southern counties) that they could only be considered as patrols; and of these about one-fourth were armed with lances, and half that number with harquebuses or petronels. The Queen appears to have supplied few if any small arms; her stock of them had, perhaps, been used up in the Netherlands, and they were not made in England. But ammunition could be procured in England, and if there was one article that a foreseeing Government would have taken care to ensure the supply of, at such a time, it was surely gunpowder. The only advantage, however, given to the counties, in this one matter, was the liberty to purchase the Government powder below the market price; and the want of forethought in providing for the supply for the Navy very nearly snatched the well-earned victory out of their hands.

The Sea Coast.

The ordnance were, most of them, supplied by Her Majesty, and the gunners also, for in those days such things were "caviare to the multitude," but the counties had to pay for them. Both bronze and iron (cast and wrought) guns were made in England at that time, and of such character and number that other nations sent there for them. The official report of the proposals for fortifying and arming the coast of Sussex (which was published by Mr. Lower in 1870) affords probably a favourable specimen of what was done generally. Along the 90 miles of the coast of this county it was proposed to place altogether 114 guns, the greatest part of which were to be demiculverins ($9\frac{1}{2}$ lbs. ball) and sacres ($5\frac{1}{2}$ lbs. ball); only in Winchelsea Castle (or Camber, as it was called) and Rye there were a few cannon (60 lbs. ball), curtal cannon (41 lbs. ball), demicannon ($30\frac{1}{2}$ lbs. ball), and culverin ($17\frac{1}{2}$ lbs. ball). Of the above, 6 sacres were to be mounted and used as field-pieces, and this was the proportion of field-pieces proposed for each of the southern coast counties, for which they were to provide teams of horses, and carts for ammunition. For the field-pieces one hundred weight of "canon corn powder" was to be provided per gun, which, at an average charge of 4 lbs., would be 28 rounds. It is curious that the points selected for defence on the coast of Sussex are almost exactly the same as those selected by a committee for the same object in 1870, showing how little the general features of the coast have altered in three hundred years; and that the "sconces, trenches, flankers, and scarpings" then recommended would be equally, even more applicable to our modern arms of precision. The sea-coast is an everlasting defence, suitable for all ages, requiring, in addition, only parapets to cover the defenders, and the greater the precision and quickness of the weapons, the more suitable is the sea-coast for a line of defence. The number of guns is about the same as that proposed in 1870, though, from the immensely increased size and range of them, they can now be placed to greater

advantage along the coast. In Norfolk, places were selected where the sea-banks were to be cut to flood the levels.

The second line of defence, the 22,000 men of Tilbury, was well placed to meet what was pretty well known to be the direction of the attack, for there was a floating bridge (made of "western barges") over the Thames there, so that the troops from the north could cross over in time to take an enemy on the flank, if he landed in Kent or Sussex. And there were batteries at nine places between Tilburyness and Woolwich, and another floating-bridge at Blackwall.

Kent was remarkable, not only for the large proportion of soldiers actually raised and armed, but for the number of mounted musqueteers—a peculiarity which seems to be handed down to the present day.

But if the county Militia made but a poor show in numbers, arms, and ammunition, their rulers seemed to think, with Henry V, that it was more to the purpose to "show the mettle of their pasture;" for they were better paid and fed than any soldier is now. The Dorsetshire labourer would be glad now-a-days to enlist if he got 4s. a day, which is the present equivalent of the 8*d.* a day the Militiaman of his county got then, when on duty; and the Militia Captains would, no doubt, be glad to return to the rate of £5 per day of training, which they got then. There was a good commissariat staff to ensure the supplies, two purveyors, one surveyor of victual, and one carriage-master to each division of a county, and a victualler to each captain; but evidently, from the rations allowed, there was no control department.

We may smile at the idea of the 3,000 men of the Norfolk militia attempting to stop the 30,000 veterans of Parma, from marching upon London; but the very fact of the county people alone proposing to do it, is an evidence of the bold and patriotic spirit that animated them. The letters and reports from the counties at this time, are full of the English fearlessness of danger. Lord Sussex from Hampshire, writes, "the poor say, he that would not sell horse and cart to defend his country, it were a pity he had any." Sir T. Scott in Kent, though the Queen is drawing largely on his forces for her own body guard, seems to have no fear of the result. Stowe, the London Merchant-tailor and chronicler, describes, "the cheerful countenances of the soldiers marching to Tilbury—joyful at the news of the foe's approach—and when they heard they were fled, began to lament." The Earl of Pembroke offered 300 horse and 500 foot, armed, at his own cost. The city of London was asked for 5,000 men and 15 ships; they voted 10,000 men and 30 ships.

Supineness of the Government.

But all this time the Queen and her Council, who should have appointed men with authority and ability to superintend the drilling and disciplining of the county forces, and have raised funds to supply and pay them, contented themselves with writing despatches to the Lord-Lieutenants, in an official style worthy of the most bureaucratic Government. In 1572, a Royal Defence Commission was appointed; the Queen was already alarmed, and apparently wished to make a show

of doing something, for nothing seemed to have been done till 1586, when instructions were issued to the Lord Lieutenants, which were repeated with additions in the spring of 1587, and yet at the end of that year (when, be it recollected, Philip intended to have done the deed), Lord Treasurer Burghley, in issuing further instructions, incidentally remarks that he has received no returns or answer to his former ones, and though, in the course of these instructions, he talks very wisely about foreseeing things in time, and by due preparation, serving the purpose with fewer soldiers; he also desires "certificates in writing as "to the execution of these orders, *yearly!*" and in April, 1588 (the Armada then starting), he once more complains of receiving no replies, but "the Queen *hopes* they have put in execution her former orders." And then, after the manner of dilatory administrators, he got frightened, and Sir John Norris was appointed Captain-General over the maritime counties, to consider among other things "whether it be "not convenient to have some troops in such places as the enemy are "likely to land (considering the enemy is in a readiness), *to be continued for a time in Her Majesty's pay, whereof some part to be borne "by the county.*"

No wonder the people took it easy in their preparations, when there was so little earnestness at head-quarters: and no wonder Sir E. Stanley, in Cheshire and Lancashire, found that there had been no training (even for the regulated six days) for two years past, and little desire to spend money on preparations; and that the Spaniards (well informed from England) conceived the idea, that through the peace of thirty years, the English had become "a pacific, delicate, "effeminate race, dependent on good living, without experience of war, "quickly fatigued and discouraged;" when some of the best Englishmen could fear of the effect of "our long quietness," and say that "God had stirred up the war in the Low Countries, to be a school, to "breed up soldiers to defend the freedom of England; which through "these long times of peace and quietness, is brought to a most "dangerous state."

Indeed, things were looking very bad on land in England. On the 8th August, 1588 (the Armada then being at Calais) there were only 4,000 men in the camp at Tilbury, and those by no means effective. Of the army of London, the Queen's Guard, there only existed the contingent supplied by London itself, and the Commanders had a very poor opinion of that. The county forces were probably at their posts, but we may presume from the above, that the reserve was—where reserves appear generally to be—nowhere. Lord Huntingdon (commanding in the North) says, in June, that he wants "Money, men, "armour, ammunition, and victuals." And even the favourite Lord Leicester, who was put in command of the imaginary force at Tilbury, is constrained to speak out by August, with more force than grace: "I see many causes to increase my former opinion of the dilatory "wants you shall find upon all such hurley burleys—I prefer Her "Majesty's life and safety, and the defence of the realm, before all "sparing of charges in the present danger,—play not away this kingdom by delays—Her Majesty must deal liberally. 'For your

" 'army, it is more than time it were gathered about you' (this is to the Queen herself)—'for the placing of it, no doubt, I think, about "London the meetest—so soon as your army is assembled, let them "by and by be exercised." These sentences are emphatic, when we consider that the enemy was at the gates when they were written.

We are obliged moreover even to blot out that historical chivalric visit to the army of Tilbury; not that the Queen was wanting in the personal valour of her race, by any means, but for the simple reason that there being then no army at Tilbury to visit, the celebrated occurrence did not take place till after the Armada had disappeared from the scene. Had she gone before, the famous Governor of Tilbury Fort might have said as truly of the British Army as he did of the Spanish Fleet; "the British force thou canst not see—because there's none in sight."

Comparison with Present Forces.

But what a lesson this is to all rulers of the British empire, on the defence of the islands of Great Britain itself. There were men enough then, with strength and spirit enough in them to make a very fair resistance to the landing and advance of any invading army, if they had been embodied, and trained, and disciplined, and armed in time: and if the practice of the bow had not been allowed to die out, before that of the new fire-arms commenced. As it was, if by any accident the invaders had got clear of the British fleet, there was nothing that could be called a serious obstacle, to stop them from capturing London. *If that same proportion of one twenty-fifth of the whole population, was now trained, it would give a force of one million, which would be sufficient to place 350 men per mile round the coast of England.* And if the favourable landing places were prepared beforehand, with cover for the defenders and obstacles against the invaders, and the men were armed and well trained with breech-loading rifles, that number would go a very great way towards defeating altogether, any attempt at landing by the greatest possible force that could land on a given distance. It would be a force like the ancient county Militia, levied, trained, and fighting at the places they lived in, and would, therefore, tend more than any other, to keep up the martial spirit of the people. But it is evident from this part of the story of the Spanish Armada, that if any dependence is to be placed on any such force, it must be so organised, that there will be no fear that they will not always be accustomed to discipline, and well trained in the use of the rifle: and I think, after what we have heard, it would not be amiss to add, that they should at least while embodied, be well fed.

And now what proportion of that armed million of Englishmen, are we prepared to raise on such an emergency? 130,000 partly trained militia, and 150,000 volunteers, who, as their title implies, may come or stay as they please. For the rest of the security of our great empire, we depend on 150,000 regular troops, who are just enough to occupy our military posts over the world in peace time; and to reinforce whom on the outbreak of war, we have at the most about 30,000 old soldiers. Thus, taking the favourable view that all those numbers would be

forthcoming on sudden demand, we have under 500,000 men, or one half of the proportion of the population considered necessary in 1588; and to defend an empire, probably twenty times as great. The security of our dependencies, none of which existed in those days, would now absorb the whole power of those 150,000 regular soldiers, leaving our own shores to be defended by a force of militia and volunteers one-third the strength of what the founders of our empire would have raised.

Cost of Land Forces.

The cost of all the forces and all the preparations made on land for the Armada, cannot be easily obtained, if at all; because the bulk of it was raised and paid in the counties, without the intervention of the central authority. If we judge by the rate of pay to the officers and men of the Militia, it was a much more expensive army than our present regular force. Mr. Bruce gives the statement from the county of Northampton in 1588, of the expenses of levying, clothing, and supplying with ammunition and their stores (not arms), and pay for five days' training, for 600 men, which amounts to £1,172; of which the pay of the men was only £86. In 1872-3, the pay of the rank and file of the British forces amounted to about one-fifth of the estimate for the whole expenses of the effective force. If we assume that the pay of the rank and file of the Militia at the time of the Armada was half of the whole expenses, we shall probably be near the truth. Taking that proportion; and assuming the whole 160,000 to have been embodied, and that the pay of heavy horsemen was 1s. 6d. a day; that of the light horseman 1s., and of the footman 8d.; the total cost of the whole rank and file would have been nearly £250,000 per month; and the total cost of the whole preparations on land would have been £500,000 per month; and if we take the purchasing power of money in the necessities of life, at that time, to have been six times as much as it is now, the above sum would be equivalent to £3,000,000, or about 15s. per head of population *for the month*. The total cost of the British Army and appliances for 1872-3, was estimated at £14,824,500, which would be less than 10s. per head of the present population, *for the whole year*.

It is true that during the time this Militia force was not embodied, there was hardly any charge upon the country; but considering that they were in fear of the invasion for a whole year, the whole force must have been embodied for a period of altogether three months; at all events we may assume that the country was quite prepared to pay the necessary expense for such a time. This would, therefore, have been equivalent in our day to £9,000,000; and if we take the difference in population into account, it would be equivalent to our spending £72,000,000 on a war that lasted three months, and that for the army only.

NAVAL PREPARATIONS IN ENGLAND.

The aspect brightens when we look towards the sea. Not that the Government used more diligence on the sea, than they did on the land,

but the English Navy had a field for their energies more independent of the Government. Fortunately for England, the people had never lost that attraction to the sea, which made it seem part of their country; and the maxim of Alfred, "That England only enjoyed peace from "invasion when her fleets were powerful enough to repel it from her "shores," had never been altogether forgotten. In the reign of Elizabeth, the new field for sea enterprise in the Indies, coming at a time of comparatively long peace, had revived the national predilections, and had created a race of adventurous seamen, and made the fleets of England once more claim dominion on the "narrow seas." Thus there was a material of ships and experienced seamen ready to make use of, and in the temper to use themselves.

It is somewhat difficult to arrive at the precise numbers of vessels in the Royal Navy and of merchants employed on this occasion, because the numbers are given for different days of the whole affair, in the course of which some became disabled and others were added. By taking the names of all vessels of all kinds mentioned in the records of the time, as given by Bruce and Dodsley, it appears that the following numbers were employed at one time or other:—

	Nos.	Tonnage.	Guns.	Men.
Royal Navy	35	12,690	658	6,361
Merchant and private ships	161	20,000	400 ¹	9,070

These were divided into two fleets; one under the Lord Admiral, Lord Charles Howard, containing two squadrons; a squadron under himself with Sir John Hawkins, as Rear-Admiral of 17 Royal and 52 merchant ships (chiefly victuallers), and a squadron under Sir Francis Drake, as Vice-Admiral of 6 Royal and 34 merchant ships. This fleet was stationed at Plymouth. The other fleet was under Lord Henry Seymour and consisted of 12 Royal and 52 merchant ships, of which 23 were furnished by the Cinque Ports, and the remainder by the City of London. This fleet was stationed in the Downs.

The Royal ships averaged about 300 tons, 14 guns, and 140 men; the largest, the "Triumph" (Sir Martin Frobisher), had 1,000 tons, 40 guns, and 500 men. The merchant ships averaged about 130 tons, varying from 30 to 400 tons, of which about half were above 80 tons.

Thus it will be seen that although the total number of vessels employed on the English side was greater than that of the Spaniards, the tonnage was little more than one half, and the number of men and number of guns were not more than one half of the adversaries. The English ships had the advantage of having a fewer number of persons on board each ship, and that a much greater proportion of that number were efficient seamen.

¹ Estimated only.

Composition and Strength of Naval Forces.

The composition of the English fleet and its strength compared with population, deserve consideration. The total tonnage of all kinds gives about one ton to every 140 of the then population of England. The tonnage of the present ironclad fleet of Great Britain gives about one ton to every 80 of the population. The number of men on board the Royal ships was about $\frac{1}{750}$ th of the population. The numbers included in the Naval Estimates, now-a-days, are altogether about $\frac{1}{40}$ th of our population. The total number of adult males in the seafaring professions of that time, judging by an estimate made in 1572, must have been (including the Royal Navy) about 22,000, or about $\frac{1}{200}$ th of the population. The number of adult males in the present seafaring professions (including 60,000 in the Royal Navy)¹ is about 350,000 or about $\frac{1}{60}$ th of our population. Thus the fleets, both Royal and mercantile, and the whole marine of the country were small for their day, as compared with our time. The remarkable point is the very large proportion of this small marine, that was available for the defence of the country. The men in the Royal ships were about $\frac{2}{3}$ ths of the seafaring men, and the whole number employed was about $\frac{2}{3}$ ths of them. If we take the former of these to represent the peace establishment of the Navy, that proportion would give us now about 100,000 men, in place of the 60,000¹ we annually provide for. And if we take the latter to represent the war establishment, that proportion would give us 250,000 men. During the great war with France, at the beginning of this century, we employed nearly 150,000 men in the Navy; and I believe it has been estimated that we should now require at least double the strength of our peace establishment on an outbreak of serious war.

There were two modes at that time, in which the mercantile marine could be brought in to assist the Royal Navy. The first was by the impressment of sailors; that is to say, it was then understood that every man in the country was liable to be called upon to assist in the defence of it, either in the Army or in the Navy. This practice was used at the time, because the pay in the Royal ships was not sufficient to attract the mercantile seamen, except when a prospect of booty was added to it.

The second mode was the requirement from certain of the port-towns of quotas of ships and men to be furnished by them in war time, as a return for special commercial privileges granted to them. Thus we see that at sea, as on land, the principle was that as the wealth of the country increased, those who gained the chief profit should be prepared to defend what they had got by their enterprise. We have lost the idea of that principle, and have only kept the power of impressment in its most obnoxious form; and thus it has come to pass that with the greatest sea-commerce the world has ever seen, we have no system of securing it against a rival power, except by a costly permanent war fleet; which, though very expensive in peace, is quite inadequate for the demands of a serious war.

It is also remarkable how, in that spring-time of British commerce, all those demands on the lives and property of the sea-merchants, seemed only to rouse the enthusiasm of all to a pitch beyond what was

¹ This number includes persons of all classes, and the Royal Marines also.

required of them. The port-towns not only supplied vessels beyond the quotas asked, but private persons equipped and themselves brought ships to the support of the admirals. The spirit of the people having been preserved and organised, rose equal to the great occasion. The action of the English at sea, at that period, may be fairly compared to the deeds of Greece at Salamis. The English, like the Greeks, virtually took to the sea with their whole available maritime force, and their spirit was an earnest of their ability to do the work before them. The tone of all the letters is like that of Nelson and his sea captains; exultation at the opportunity of at last having a good fight with the great rival; a clear perception of the difficulty, but also a resolute mind to meet it, and a confidence in their intimate knowledge of the ships they were to fight in, and the sea they were to fight on.

As was said in the *Times* the other day, commenting on the works of that gifted and patriotic writer who died last month,¹ "It was well for us that English commercial enterprise took that form in the days of Queen Elizabeth. Had these Devon gentlemen stayed at home tilling their paternal acres; had Hawkins, Forbisher, and Drake, confined themselves to coasting voyages in the narrow seas, the story of the Armada would have ended differently, in spite of the elements; and in place of being mistress of her vast Colonial Empire, England might have seen herself a province of the House of Austria."

Construction of Ships.

With respect to the size and construction of the vessels, the opinion of the experienced sea-captains of the time was generally in favour of the smaller and handier English vessel. "Grande navis grande fatica," says Sir Walter Raleigh. Lord Howard calls his ship (the *Ark Royal*, 800 tons), with evident delight, "a little odd ship for all conditions." When the adventurous mariners of England took to the great ocean, they were obliged, no doubt, to give up the galley, from want of labourers for the oars, and to use small sailing-vessels manned by a few very good seamen; and to compete with the great Spanish galleons, they had to be quick and handy. This suited their genius, and they and their ships became famous together; but we must not assume that the smaller size was deliberately selected for a great naval war. Indeed, the English seem to have been quite as much behind hand in the theory of shipbuilding then, as they have been almost ever since; and to have borrowed their ideas from the Netherlands. Lord Howard's first demand after his first engagement with the Armada was for larger ships; and, as we have seen, Sir W. Monson preferred larger vessels and a proportion of galleys for sea-fights. The whole of the vessels of that period of all nations, apparently, carried so much top hamper as to be obliged to give up a large part of the hold to ballast; hence the number of attendant victualling ships; the victualler was to them what the collier is to a modern squadron, and gave the limit of their cruising power. This was also limited by the unwholesomeness of the vessels after a short time; the number of men put *hors de combat* by this cause was a very serious loss both to the English

¹ The late Canon Kingsley.

and Spanish fleets, but more so to the latter on account of their crowded state. Otherwise the English ships appear to have been very well built, as far as the workmanship was concerned, and cheaply.

The armament of both Spanish and English fleets was probably alike in point of size of guns. Sir W. Monson gives a list of the guns in use, and says that demi-cannon ($30\frac{1}{2}$ lbs. ball, carrying 170 paces point blank) was the largest gun commonly used on board ship. Sir W. Winter mentions culverins ($17\frac{1}{2}$ lb. ball, 200 paces P. B. range) and demi-culverins ($9\frac{1}{2}$ lb. ball, 200 paces P. B. range); and, after the second day's fight, Medina Sidonia sent off an express to Parma for 4, 6, and 10 lb. balls. The ranges of the guns given by Monson should be borne in mind in the account of the fighting; some of the English guns being, no doubt, of good iron construction may possibly have been better shooting guns than the bronze pieces of the Spaniards.

Government Delays.

The Royal drag had not, therefore, the same effect on the wheels of Neptune's car as it had upon the chariot of Mars. It was felt, however, and produced quite as much noise. Hawkins wanted to cruise off Spain, but the expense (£2,700 per month) was too much for the great Queen. What a Chancellor of the Exchequer she would have made for these days! Lord Howard complains, in March '88, that Sir F. Drake's squadron is not allowed to be completed, and that some of the large men-of-war are kept lying idly in the Medway at Chatham, "to defend the church there," he supposes: "sparing and war have 'no affinity together.'" "Money and jewels will not redeem the 'time.'" And he includes Lord Burghley among the economists. "I 'pray we do not curse, for this, a long grey beard with a white head 'witless.'" Mr. Puff was apparently right when he called on Lord Burghley to shake his head as if there was something in it.

There were alternate panics and fits of economy worthy of the most peace-devoted government of commercial days. Even in the beginning of 1588, when we know Philip was hoping that Parma was already in England, the fleet was much dismantled, and many seamen allowed to go; and immediately afterwards they had to be refitted at a greater expense, and an inferior lot of men taken to replace those who had gone to seek employment elsewhere. Then, at a time when the goodwill of the sailors was of so much importance, the rations were reduced, and issued monthly, with such delays, that the fleet was short of food during the whole operations. It appears as if the Government of England, at the time, was unable to realise the crisis, which we can see now was occurring in the fates of Spain and England; that the former, if not checked, would inevitably continue her course of aggrandisement, and swallow up first Holland, then England; and that the latter was at a point in her existence, at which the people were both prepared and able to rise to the occasion, and gain a new footing in the world in fair fight.

One can hardly believe it possible that such infatuated economy existed in those great days, but we have an instance in our own days of the deliberate blindness of a Government in like case. In 1858, when

there were rumours of war in the political air, the Royal dockyards of England were allowed to get reduced into such a condition that if the whole force of them had been put on the work of fitting out the vessels lying in harbour for war, irrespective of building new vessels and of chance repairs, it would have taken two years to do the work.

A list of the whole of the Royal ships mentioned in Bruce, as having been employed on this service, is appended, and in it will be seen several well-known names in the British Navy. If any record were to be put up in this Institution of the historical deeds of the Navy, I do not think that there could be any names more worthy to commence the list with than those of the captains of these ships. And of all those names, many of them renowned in the world, I feel certain that there could not be a nobler one to head them than that of Lord Charles Howard. A nobleman of England and a Catholic, he sacrificed his feelings and his ease, and, without hesitation, drew the line between his adherence to his faith and his allegiance to his sovereign. Throughout the whole proceedings he shows the high-minded honesty of an English gentleman, coupled with a skill and gallantry worthy of the best days of British seamen.

Preparations in the Netherlands and in Scotland.

We must not omit the preparations made by the United States of Holland towards counteracting the Armada, for, without them, the junction between it and Parma would have been effected, and that great commander would have made a much more vigorous effort to land his troops in England. In the autumn of 1587, as soon as Parma had taken Sluys, they blockaded that port, and Newport and Dunkirk; and, by April, 1588, they had 90 war ships and 50 merchanters, varying in size from a gunboat to 1,200 tons employed on this service. The large square-rigged vessels were stationed between the Flemish Coast and England, those of smaller size lay within the banks off the former, and the sloops and flyboats lay close in-shore. The admiral of Holland was Warmond, and the admiral of Zealand was Juan de Nassau. These fleets, it will be seen, played an important part not only in blockading Parma, but in assisting to secure the results of the victory gained off their shores. And even after the great Armada had disappeared into the North sea, the danger that was still apprehended from Parma (so great was his renown) was so felt, that the English admirals showed great anxiety to get back to the Flemish Coast to watch him.

Neither must we omit to record the part played by Scotland. The young King James had been personally doubting which side to take, but the mass of the people of Scotland settled the question for him, by showing, unmistakeably, like the English people, their determination to adhere to the Reformed religion. In 1586, King James made a definite treaty of mutual defence with Elizabeth, in case of invasion of either country. Nevertheless, in June, 1587, Philip spoke of a simultaneous invasion from Scotland, when the Armada should appear by troops in his (Philip's) pay; but these were apparently to be furnished by the nobles of the Catholic party in Scotland. It, however,

so far affected the arrangements in England that the militia forces in the northern counties were all kept there.

Cost of the Naval Preparations in England.

We have got considerable data on the subject of the cost of the fleet, in the accounts of Sir J. Hawkins, the controller (who appears to have had as sad times under the Tudor sovereigns, as ever a controller of the present day had under the most economical Government). But there is a difficulty in determining the whole cost of the naval preparations during the year in which they were expecting the Armada; because the Queen, in her anxiety to save expense, ordered ships into harbour as often as she could, and the crews were either paid off or put on reduced rates, and the bulk of the expense of the merchant ships fell on the seaport towns which furnished them, or on private individuals. Sir J. Hawkins gives a statement of all the expenses paid by him for the eleven months, from 1st November, 1587, to 30th September, 1588, for H.M. ships, coasters, and volunteers, over and above the charges borne by the seaport towns and others, and not including victuals. This was £77,295, of which about £24,000 appears to have been spent on merchanters. In Bruce, there is an estimate of the cost of victualling H.M. ships and others for 18 months, from 1st July, 1587, to 31st December, 1588, which was £66,331, of which about £20,440 was for merchanters. From these two accounts the total cost of the 34 Royal ships, during 12 months, would have been about £90,000.

For estimating the cost of the merchant ships engaged, we have the following data:—The tonnage paid by the Crown to the owners, was at the rate of 2s. a ton per month, which, for the 20,000 tons employed, would be £2,000 per month. The wages of the seamen so employed were 14s. a month, and their victualling was estimated to cost as much more, so that the 9,000 men employed in the merchant ships, at 28s. per head, would have cost per month £14,600. Now whatever proportion the Queen paid, the owners of the merchant vessels would have had to incur the balance of the expense to make up that amount. Therefore it is fair to assume that the cost to the country during the twelve months could not have been less than £175,000 for the merchant vessels, and £90,000 for H.M. ships, or about £260,000 altogether. And if we take the purchasing power of money in necessaries of life to have been in 1588 six times what it is now, that amount would be equivalent to about a million and half pounds, and this fell on a population of about $\frac{1}{3}$ th of the present population of Great Britain, and consequently would be the same to them, as if we expended £12,000,000 in one year. The cost of the effective services of our War Navy at present is about £8,000,000 per annum.

Cost of the whole Naval and Military Defences in England.

Thus we see that the people of England had made arrangements for the defence of their country, which would have involved an expenditure for army and navy in the course of twelve months of a sum which would be equivalent to about £90,000,000 at the present day,

which is more than the cost of our naval and military forces in 1813—the most expensive year of the great war with France—and double the cost of the Crimean war in 1856.

THE ATTACK AND THE DEFENCE.

The plan for the invasion of England, originally proposed by Parma and finally adopted by Philip, was virtually the same as that of all other intended invasions of this country, since England was one united kingdom: namely, to land the main body of the invading forces as near to London as possible, and to make straight for that city. But to carry out this plan in this case, it was necessary that the naval part of the expedition from Spain, should first clear the seas of the hostile fleets, before the military part from the Netherlands could venture to cross over. Philip does not appear to have realised the probability of a great naval action; his idea was to effect the junction without the knowledge of his enemy, and so to take England by surprise. This involved the dangerous expedient of passing with his fleet along the whole south flank of his enemy's position; an operation which looks impracticable with a force like the Armada, in those days of slow sailing vessels; Sir W. Monson, however, says that if they had followed Philip's orders, they might have got to Calais in time to defeat the Dutch fleet, before the arrival of the English fleet, and so to have embarked Parma's forces. As it turned out, it was precisely this scheme of secret combination of the two parts of the expedition which ruined it. Had the Armada come the year before, when the Queen and Burleigh were writing official reminders to the Lords Lieutenant, this plan would probably have succeeded.

Philip's original idea appears to have been three or four simultaneous invasions; one in Ireland, the Armada in the Isle of Wight or some western port, Parma on the east coast, and a force from Scotland.

The report in England (according to Stowe, and probably spread by Philip) was, that a French force was to be landed in the west, Parma in Kent, and another force in Yorkshire. The Queen must have well known that France was in no condition to assist in such an undertaking. This plan of Philip's would have had a good chance of success, provided the whole expedition had been previously arranged for it; as it was not so arranged, Parma objected, and Philip so far yielded, that it was settled, that after Parma's force had landed, and succeeded (of which they had little doubt), the Armada was to return and take the Isle of Wight, as a stronghold, and after that to proceed to Ireland.

There was a very fair prospect of success, from the Spanish point of view. Parma had obtained information about England, and had selected the neighbourhood of Deal for the landing place, and the time after harvest, because of the fertility of Kent and the unwarlike character of its inhabitants (there was a greater force of horse and foot raised in Kent, than in any other county); there were no fortified cities in England as in the Netherlands, and London, even then remarkable for its wealth, was altogether defenceless. It was long

since the English infantry had appeared with success on the battle fields of Europe, and altogether there was little expectation of a defence like that the Netherlands had made. The fault of the failure in this promising programme lay not in his calculations and preparations.

Sailing of the Armada.

On the 30th May, 1588 (new style, which will be followed throughout), the Armada at last cleared out from Lisbon. The character of their movements is well illustrated by their having waited a month for a fair wind, and then being three weeks in reaching Cape Finisterre (300 N. miles). Then they were dispersed by a storm, which proved the inefficiency of some of the ships: of the four great galleys, one foundered, and two were captured by the slaves on board, led by a Welshman of the name of Gwynne, who must be recorded as one of the heroes of the Armada time. The fleet sheltered in Corunna Harbour (called the Groine by the English), and were so injured and had so many sick, that it was the 22nd of July before they put to sea again.

The instructions issued to the fleet by the Duke of Medina Sidonia (given in Bruce), show a religious zeal, but a military martinetism quite unsuited for a naval expedition.

The English fleet lying at Plymouth, appears to have been remarkably deficient in intelligence as to the movements of the enemy; which may be partly accounted for by the Queen's refusal to allow men of war to cruise off the coast of Spain. They had been ordered to cruise in "the Sleeve," as they then called it, against the advice of the Lord Admiral: provisions were the turning point of a cruise then, and what the Lord Admiral feared most, was meeting the Spanish fleet when he was short of them, and he even thought it would be part of their plan to starve him out of the way. This is what would occur now, substituting coal for provisions. The last they heard of them was their being driven in "the Groine" by the storm; the Queen heard of this too, and characteristically ordered some of her war ships to be immediately dismantled; an order the Lord Admiral fortunately delayed to execute, as he almost immediately heard of the arrival of the Armada at the Lizard. There is a fine letter from Lord Howard to Secretary Walsingham, of July 6th, showing his noble and sailor-like character; after discussing in good seamanlike style, the *pros* and *cons* of the case, he finishes with, "we must proceed by the likeliest ways, and leave unto God to direct for the best, and so I bid you heartily farewell.

"From on board Her Majesty's good ship the 'Ark,' the 6th day of 'July, 1588.

"From your assured loving friend,
"C. HOWARD."

It turned out that what they had been doing was for the best; for the Spaniards at Corunna were also deceived by a report that the English fleet had been dismantled in Plymouth Harbour, and by the advice of De Valdez, their best sailor, Medina Sidonia determined to

disobey his orders, and attack the English fleet in harbour; for which Valdez was afterwards imprisoned for life. They would, however, have succeeded in surprising Lord Howard in harbour, but owing to their ignorance of the English coast, they mistook the Lizard for the Ram's Head at Plymouth, and stood off for the night, intending to enter in the morning. By this delay Lord Howard had had time to warp his ships (60 in one night) out of the Catwater where they then lay; and to the disagreeable surprise of the Armada, as they came along the Cornish coast on the afternoon of Saturday, the 30th July, about 15 miles west of Plymouth, they found some 70 English vessels ready to receive them.

What a night that of Friday, the 29th of July, 1588, must have been in England: when the thought of it warmed the philosophic Macaulay into patriotic verse:—

It was about the lovely close of a warm summer day
There came a gallant merchant ship full sail to Plymouth Bay;
Her crew hath seen Castille's black fleet, beyond Aurigny's isle,
At earliest twilight, on the waves lie heaving many a mile.
Night sank upon the dusky beach, and on the purple sea,
Such night in England ne'er had been, and ne'er again shall be,
From Eddystone to Berwick bounds, from Lynn to Milford Bay,
That time of slumber was as bright and busy as the day;
For swift to east and swift to west the ghastly war-flame spread,
High on St. Michael's Mount it shone; it shone on Beachy Head.
Far on the deep the Spaniard saw, along each southern shire,
Cape beyond Cape in endless range, those twinkling points of fire.

The running Fight in Channel.

And now we come to that remarkable running fight which lasted nine days and extended over 400 miles; but I am not going to attempt a detailed description of this tournament of ships along the coast of England, when there exists so admirable a picture of it in that charming book "Westward Ho," and such full accounts of it in Mottley and Froude. There are, however, some points about it, which are, I think, worthy of attention in these days of discussion on naval tactics; a fleet of comparatively small ships, over that time and distance, got the better of one of large ships, by artillery at long range. And this was done, not by construction or armament, for these were generally the same in both fleets, but by three qualities; swiftness and handiness of the ships, and good seamanship. There are some reservations to be made in the first part of this long fight, but the great final battle appears to me to teach a clear lesson about guns, as I shall point out when we come to it.

The Spanish fleet sailed in what Admiral Monson calls "the portion of a half moon," the centre advanced, the wings thrown back; the Admiral in the centre, with the Rear-Admiral behind him, the great galleys and galleasses on the flanks. As there was no sailing close on a wind in those days, the orders were simple; no ship was to go a-head of the Admiral, or astern of the Rear-Admiral: Hakluyt, speaking of their good order of sailing, says they were "three or four 'in a rank,' following close up one after the other; and Camden says

they stretched seven miles; this agrees with the drawings in Adam's and Ryther's book. And in this order they advanced slowly along the coast of England, before a S.W. wind and a smooth sea, such as one expects to find in the channel in August. The Duke of Medina Sidonia, after finding out his mistake about the English fleet, resolved to make straight for his rendezvous at Calais without stopping for anything. The English fleet would have got to close quarters and boarded, if they had dared; but the Spanish vessels were too high to run such risks; and Lord Howard knew well that the issue to England depended mainly on his thirty ships of war. So he let the Armada pass, and kept behind, that was to windward, and ordered that his ships should not allow themselves to get closer to the enemy than good cannon range, 200 to 400 yards. Divided into four independent squadrons, they carried out this idea so well, that even, when by a slant of N.E. wind the Spaniards got the weather-gage, they could not close upon any English ships: and the Spanish Admiral was obliged to place his best galleys in the rear to cover his progress.

The Spaniards describe the English fleet, during the progress in the Channel, as sailing along the rear of their line, firing into their vessels in succession, and that they in vain attempted to get alongside of them by crossing their courses. They mention particularly the Flag ship, the "Ark Royal," which, the wind being at the moment easterly, had run into a Spanish vessel and damaged her own rudder, and yet, before another Spaniard could close upon her, she got her head pulled round by her boats and sailed away from them. They were also astonished at the quick firing from the English guns, which they say was four to one of their own.

I said there were reservations on this part of the fight. Firstly, the Spaniards could not manage their own ships; they repeatedly fouled each other, and their losses in the Channel were almost entirely occasioned by the English capturing their ships damaged and left behind by their own fault in this respect. Secondly, very little damage was done on either side by the firing, although each side fired away the greater part of their ammunition. This was partly bad gunnery; the master gunner of the English flag ship (who corresponded direct with the Secretary of State), was as angry as if he had been director of the gunnery ship of the day: and some of the Spanish guns were so high (in their castles) that they could not depress them sufficiently to hit the low English hulls. Thirdly, neither side was satisfied with the result: one can understand the Spaniards being dissatisfied and sending off express to Parma for "fly boats," to chase the English ships; but it is curious to find the English Admiral also sending off express to his Government for larger ships to board the Spaniards with. He was gaining a victory without knowing it.

An episode occurred at this time, illustrative of the importance, even in those days, of having a war harbour about Dover. Lord Henry Seymour, who commanded the squadron stationed in the Downs to assist in watching the Flemish coast, came westward as far as Dungeness on hearing of the arrival of the Armada. But, running short of provisions, and hearing nothing more, though the Armada

must have been almost in sight, he returned to the Downs on Saturday morning, August 6th; and before he could revictual, he received orders to join the Lord Admiral off Calais. Now if the Spanish expedition had been arranged so that Folkestone had been one point of debarkation, it would have been effected before Lord Henry could have arrived to assist in preventing it; for the wind was so light, that it was evening before he joined the Admiral.

The Anchorage at Calais.

On Saturday evening, August 6th, 1588, the two hostile fleets anchored off Calais, within one mile and a half of each other; about 130 vessels in the Spanish fleet, and 140 in the English; the Spanish fleet to the westward, in the more sheltered position. And there they lay all Sunday. Perhaps no British Admiral before or since has had so important an issue resting on his shoulders, as Lord Charles Howard had that night: the fate of England depended on his action. The enemy were still virtually intact; they had steadily pursued their course in spite of the English fleet; and after their junction with the Prince of Parma (of which neither side had then the smallest doubt), that fleet would be still less able to stop these mighty ships from crossing the short distance further to the English coast; and if they once landed there, the Lord Admiral knew there was little to oppose them. Little did he imagine that the mind of the Spanish Admiral was equally filled with doubt as to his next move.

Whether from natural incapacity, or jealousy of the rival commander, Medina Sidonia does not appear to have contemplated the idea of forcing his way up the Scheldt to effect the junction; he expected Parma to come to him. Parma set to work with great energy and got 16,000 men (all that was left of the 30,000 of six months previous) on board his transports at Dunkirk and Newport, but he could not move out in face of the Dutch fleet. Thus were the two component parts of this mighty expedition, lying within thirty miles of each other, each waiting for the other. There was still great enthusiasm and spirit among the Spanish forces, though there was, no doubt, some fear of the English seamen. There also was lying the English fleet, animated with equal spirit and greater confidence, but yet not daring to attack the tall galleons filled with men, while they were at anchor; if they had had equal sized ships, they would, no doubt, have anticipated the tactics of the battle of the Nile; as it was, the only question was, how to force them from their anchorage before Parma could join them. A modern naval tactician would have been only too happy to have got such an opportunity of bringing his rams and torpedoes into action. There were no vessels suitable for ramming in the English fleet, but the torpedoists will be gratified to know that that weapon was virtually brought into play, and with remarkable success.

Sir William Winter (then apparently a Commissioner of the Navy) came on board the Lord Admiral's ship to give his advice under the circumstances, and then saw the great Armada for the first time: "and having viewed the great hugeness of the Spanish Army, did

"consider it was not possible to remove them but by a device of firing "of ships, which would make them leave the only road which was "meetest to serve their purpose." And in the middle of Sunday night—a dark, cloudy night, with flashes of lightning—the Spaniards suddenly beheld six fire-ships coming down before the wind and tide upon them, all ablaze. Fire-ships alone were well-known expedients, and might have been met without endangering the existence of the fleet; but, not long before, an Italian engineer had employed against the Spaniards in the Netherlands some kind of floating torpedoes, which, coming down the Scheldt at Antwerp, had blown up a floating bridge and some vessels, and many men. This was well known in the Armada, and it was also known that the Italian engineer was then in England, and these fire-ships were supposed to be of his invention. A panic seized every ship in the fleet; Medina Sidonia in vain attempted to preserve order; before morning, the whole Armada had cut their cables and got under way. Gianibelli, the engineer, must also have a place among the victors of the Armada.

Once more, then, the great line of the Spanish fleet is going before a fresh south-west wind up the deeps of the Channel, between the Goodwin Sands and the coast of Flanders. But the gallant, though incapable Medina Sidonia, exasperated against Parma for, as he thought, deceiving him, now resolved to act for himself. He reformed his line and when the English fleet came up with them again, he turned, and the great decisive battle between England and Spain at last took place.

The Battle off the Goodwins.

About 8 A.M. on Monday, the 8th August, 1588, the fleets neared each other. Lord Howard had determined his plan of attack, in three independent squadrons; but this was upset by his remaining behind to assist some small vessels, whose boats were capturing a great galleass, which had grounded at Calais; so the impetuous Drake had the opportunity of leading his squadron against the centre of the Spanish line, in which he was followed by the equally pushing Frobisher and Hawkins. Lord Henry Seymour and Sir W. Winter attacked the starboard wing.

This was a real battle of guns. The English necessarily adhered to avoiding being boarded by the Spaniards, and kept at musket shot, that is to say, probably not exceeding 200 yards; it is difficult to understand how they avoided it, as they speak of being surrounded by these great galleons. The Spaniards must have been dispirited and the English inspirited by the night before; for the wing attacked by Winter ran into the body of the fleet, and fouled each other; and the small English vessels remained thus firing on all sides for eight hours. Winter says he fired 500 shot, which, as he had 30 guns, would be 25 rounds a gun. By 4 P.M. the Spaniards had suffered considerably; all their best ships were injured in their hulls and rigging, three large ships sunk, two or three others drifted on shore or into the clutches of the Dutch fleet; one ship is said to have had 350 shot in her, another was shot "through" six times. Strange to say, the English fleet

suffered comparatively little damage; there is no mention of one single ship being put *hors de combat*, and not 100 men killed, whereas the Spaniards lost more than 4,000: Drake's ship was pierced by 40 shot. The height of the Spanish guns above the water will probably account for part of this difference of injury, but still they carried guns in their waists, and we must put it down mainly to the superior skill and confidence of the English seamen.

At 4 or 5 P.M., Medina Sidonia was warned by his pilots that he was drifting on the dangerous lee shore of Flanders, with an increasing wind from more to the northward, so he made sail away to the N.N.E., evidently unwillingly, for he retreated in good order. The English were not loth to stop either. Winter says, "When every man was 'weary and our cartridges spent, we ceased;' and says Lord Howard, 'We put on a brag countenance, and followed the enemy.'" They must have felt that they had won, but they did not know how great a victory it was; how serious a battle both sides thought it, may be judged from Lord Howard: "Some make little account of the 'Spanish forces by sea, but I do warrant you, all the world never saw 'such a force as theirs was; and some Spaniards taken say, it exceeded Lepanto.'" But neither side as yet realized that that day's fight had settled the question of the command of the sea for many years.

Now the question I would put to naval tacticians of the present day is, whether such a fight is possible with ironclads? Is it practicable to build an ironclad of comparatively small size, and which shall nevertheless carry a few of the largest guns, and yet be swifter and handier than what we may call the line-of-battle ironclads? For if it is possible to construct such a vessel, it seems that they would be able to make a fair fight against the larger vessels at long range. The tactics adopted by the English fleet against the Armada were quite different from the ordinary practice of the time. The guns were then considered so inferior to the ships, that in all naval actions the object of the attacking fleet was to get alongside as soon as possible, and determine the issue by the personal combat of the fighting men on board. The battle of Lepanto was so fought. The English fleet would have gladly followed the usual system, had they dared: they adopted the other plan in desperation of the circumstances. The remarkable thing about it is, that it entirely succeeded, and its success equally astonished both sides. It is true, the Spanish ships were unwieldy and badly handled, but they were manœuvred during the battle, and with great gallantry and some effect. It was really a question of the comparative manœuvring power of the two fleets, as well as of their seamanship and gunnery.

Now, let us consider the difference between guns and ships at that time and at the present. The gun was evidently then really superior to the ship, if guns and ships were properly handled. So much was this known to be the case, that the guns continued much the same for two hundred years after, while attention was turned to improving the ships. And this went on until, in Nelson's days, the ships became again more powerful than the guns, and the plan of battle again was

to get alongside. Then, in our own day, the guns took a start, but the ships almost immediately counterbalanced the improvement by the adoption of armour-plating; and, just now, we find naval tacticians recommending rams and attached torpedoes, showing that they consider the ship to be superior to the gun. No person can venture to say, at the present moment, to what extent the use of iron in ships and guns can be carried, or that we have arrived at the ultimate speed of ships. But there is this point to be considered—ships have apparently arrived at a resting-place, and are large vessels with slow manœuvring power, whereas the gun is still advancing, not only in size, but, what is equally important to the question, in facility of working. The size of ships has increased five-fold since the Armada; the size of guns has increased twenty-fold; there are fewer of them carried, but each is more effective, and is likely to become more accurate and quick in firing.

This is an important question for us, for if there is a possibility of the gun becoming again superior, it will evidently be to the advantage of those maritime nations which cannot afford large ironclads, to be able to use small, quick, handy vessels, at long range, with a prospect of success. And, in such case, it would be necessary for a great maritime power to have a proportion of such vessels to match them. This would not dispense with the necessity of having the larger vessels as well; but they would be reserved for grand maritime warfare; that is to say, a war for the command of the sea, which can only be settled in too ways—either by great naval actions or by the invasion and conquest of one of the powers.

The Great Storm.

The story of the subsequent proceedings of the Armada is interesting to us, as exhibiting the superior seamanship of the English, acting, as it were, in spite of the economical tendencies of the Government. Medina Sidonia made another gallant attempt to face his pursuing foe, but, owing to the faulty navigation and seamanship in his fleet and to the adverse heavens, it only resulted in the whole Armada being nearly stranded on the shoals off the mouth of the Scheldt. Then he appears to have lost spirit, and to have had thoughts of surrendering altogether. It is true that he had many sick and wounded on board, many of his vessels were disabled, his men discouraged, and his pilots ignorant of the sea they were entering. But one has only to consider the condition of the English fleet he was flying from, to learn the true cause of the failure of the expedition. Hawkins writes, on August 11th, still much afraid of the Armada, "has no victual, money, powder, or shot; men have been long unpaid;" Lord Howard, on the 17th, "powder and shot well nigh all spent; made for the Forth to refresh our ships with victuals, whereof most stood in wonderful need." Yet they followed the Spaniards (out of gun shot) up, to 55° 13' N. lat., where they left them on the 12th August; but only to refit, still expecting their return—still expecting the terrible Parma to burst forth from the coast of Flanders, for, says the humble-minded victor, "I long to do some exploit on their shipping." Then came the

great storm, like the final judgment of Heaven on the undertaking; for it was not only a most unusual event to happen in August, but the bad weather lasted all through August and September; and though the English fleet was exposed to the first burst of it, they did not lose a ship. They re-assembled at Harwich, only to find that their economical Government had made no preparation for their sick and wounded, not even for the pay due to the seamen; and to receive, in reply to their earnest request to go to sea again, such wise official reflections from Lord Burghley as these:—"To spend in time convenient is wisdom; "to continue charges without needful cause bringeth repentance."

And yet, at that moment, the Armada still consisted of upwards of 100 ships, and if they had gone to Denmark to refit, as some expected, they would still have been more than a match in material strength for the English fleet; and at that moment Parma had still his 16,000 men fully equipped. When one reads, in "Froude's History," of the Spanish ships strewn along the coast of Scotland, and of whole fleets and armies wrecked in Ireland, and of still a remnant returning to Spain, one cannot but acknowledge, with Mottley, "that the danger "was at last averted, is to be ascribed to the enthusiasm of the British "nation—to the heroism of the little English fleet—to the effective "support of the Hollanders—and to the tempest;—very little credit "is due to the diplomatic or military efforts of Elizabeth's Government."

CONCLUSION.

The spirit of a nation lies in its aristocracy, but its strength rests in the people.

If this is true, the story of the Spanish Armada teaches a lesson to statesmen in peace as well as war, for the English nation, then of little repute in Europe, showed both the will and the power to maintain their independence against the strongest, and a capability of doing something more than that. And this was not owing to unlimited freedom in trade or in person or in politics, but, as far as it was due to human foresight, was mainly the result of laws having the special object of regulating each person's position and duties in civil life, from highest to lowest, and which were executed by men in authority, who felt and were not afraid of their responsibility.

But if we take into consideration the possibility of war, the statesmen responsible for defending our empire may learn the further lesson from this episode in our history, that *one of the greatest securities for the independence of these islands is in a very large and well organized Militia*. If that little nation of Englishmen, imperfectly armed, could determine to defend their shores against a greatly superior foe, how much more should we be able now to make them impregnable? We have five times the population, two or three times the wealth per head of that population, and the most perfect weapons in the world, to defend the same length of coastline. If we multiplied our Militia by ten, and paid them at the highest rate of labourers' wages while in training, we should be doing no more than those few ancestors of ours, who laid the foundation of all our

wealth. I am not saying that it is necessary to increase our military forces immediately, but that we have lost the organization which enabled them to do so; it is not in the numbers that the defect consists, but in the absence of the spirit of being prepared to hold our position in the world. What we want is, the will to sacrifice so much of our present wealth as they did, to ensure our security. Having got that will, we should have little difficulty in these days in arming and training them, so that every man would be capable of making the most of his weapon, and accustomed to some kind of discipline.

But there is a danger, in these days of refined organization, that we shall sacrifice real efficiency for the sake of official precision, by centralizing the administration and authority. Now, it hardly requires the record of those days to convince us that the one great characteristic of all the deeds of Englishmen is, the feeling of independent authority, and with it of responsibility; it is an essential mark of a free, God-fearing nation, and any organization that does not take it into consideration fails to touch the heart of the nation's spirit. But the story of the Armada shows, in a remarkable manner, how, on the one hand, the Kings of Spain, by concentrating all authority into one centre, stifled the individual enterprise of their people, to their own loss; and how, on the other hand, the good local organization of all ranks throughout the country in England produced success, notwithstanding the supineness of the central Government. It is in this point where I think the maxim of the old Chinese general is applicable. For, in our navy, that delegated responsibility and authority has always of necessity been more preserved than in our army. The Commander of a fleet or of a ship is necessarily, even in peace, in a more independent position and with a larger sphere of responsibility than a Commander of any military force. I advocate the application of the system to a greater extent in our army than has been the case for many years—a return, in some measure, to the principles of organization of former days, which were more in accordance with our national characteristics; and I would take this responsible authority low down in the ranks of officers; not only should the local Commanders of our military forces have greater power and greater responsibility in all things, but the Colonels of regiments and the Captains of companies should be allowed a greater field for the exercise of their capabilities in providing for and keeping up the efficiency of their men. This idea, it will be said, is very contrary to the doctrines of administrative economy and Parliamentary responsibility which have been taught for many years. I can only reply, in the words of the noble seaman whose fleet saved England from the Armada:—"Sparing and war have no affinity together;" "I must and will obey; I am glad there be such there as are liable to judge what is fitter for us to do than we here; by my instructions I did think it otherwise, but I will put them up in a bag." I believe that, by striving after this formal precision in appearance—this concentrated responsibility—you lose what is of ten thousand times more value to the country—the stirring of the conscience of the real workers—the hearty feeling of a share in the power and responsibility of defending the empire.

The British proprietor, when he is organizing an establishment to carry out some private business of his own, seeks for men he can trust, and then puts entire confidence in them. But this is not the way in which they proceed in dealing with the business of the country; at least, of late years the idea has appeared to be, that the best security for the proper performance of it is to give local authorities as little power as possible, and to supervise that power with such an arrangement of checks as to take away almost all feeling of responsibility.

The one paramount lesson to be learnt by our war statesmen, from the story of the Armada, is the preservation of a race of efficient seamen. Our present seafaring population is far larger in proportion to the whole population, than it was in those days, but it is a question whether there are on the whole as large a proportion of efficient seamen among them. Then, every man who was a sailor at all, was of necessity a seaman, with a general skill in all the branches of his profession, which is more perfectly learnt with small vessels and a hazardous trade, and also of necessity having a knowledge of guns, and a resolute enterprising spirit. The parsimony of the Government prevented the employment of the best of them in the Royal Navy, but there was a large field to draw upon, and as we have seen, on emergency it was very largely drawn upon. And there was a more intimate connection between all parts of the naval service of the country, royal and private: from the nature of the ships, little alteration was required to turn a merchantman into a royal man-of-war; and indeed there was not very much difference in the operations of each; the prizes taken by the royal ships gave a better reward to the men engaged than any ordinary trading. It was, in fact, this fine prospect of fortune that made the seamen of those days; the harvest to be reaped even in the regular channels of commerce, was as tempting as blockade running, or any of our most lucrative lines of sea trade, and the prizes to be gained under a bold man-of-war Captain, were like gold diggings to the labourers of to-day.

There are no such premiums to offer in our day to enterprising seamen: the orderly government of the world and the use of steam are against these adventurous spirits, just as regular armies and arms of precision have done away with knight errantry; but there are still plenty of openings both on land and sea for enterprise for boldness and for skill; and there are still modes in which the seafaring population may be encouraged in their profession, and brought into connection with the higher duty of defending their country. There are confessedly improvements required in the interior economy of our merchant vessels, and in the condition of our sailors, and for the sake of humanity and for our trade, it will, no doubt, be the duty of the Government to interfere in these matters with a strong hand; I would advocate a more extensive interference, for the sake of the efficiency of British seamen, so that they may be raised to the highest status among the seamen of the world. There is at present, no connection worth speaking of, between the merchant service and the defence of our empire and its trade, and perhaps no such connection can be made, that will be really equal to the requirements of the times, without

trenching on the liberties and the profits of the shipowners and seamen of the country.

This question of the supply of efficient seamen has been given a startling interest this winter, by the representations of the Liverpool shipowners to the Government, of the deterioration of the British merchant seamen. And this conclusion has been arrived at, not by alarmist officers, but by patient and perfectly independent enquiry, by the commercial men most concerned in the matter. As a curious corollary moreover to the arguments I have been drawing from the story of the Armada, they couple with that announcement, an expression of the necessity for a better connection between the mercantile and the Royal Navy. Some think, and there are naval men of high authority who agree in this, that the deterioration dates from the time of the abolition of the Navigation Laws, and system of apprenticeship; but whatever the cause, all men who think seriously about the defence of their country, will agree with the shipowners of Liverpool, that it is a vital question for the existence of Great Britain. We appear to have been working for some years past on the idea, that the accumulation of private wealth by commercial enterprise, is an interest sufficient to govern the world; we seem now to be discovering, that owing to the many other conflicting interests in the world, this system fails even to govern itself; and that that country, which, like Great Britain, has devoted its energies to the realisation of the idea, has put itself very much at the mercy of those, who, not enjoying the same profits, but anxious to do so, have rival interests. Because, while the devotion to commerce has lasted, two elements of national vitality have been allowed to get into a dangerous condition. The food supplies of the people have become dependent on foreign countries, and the war spirit which should secure them, has fallen into decay. Spain would have had no occasion, now, to prepare a great Armada to invade England, in order to cripple that country; she would divert the attention of the British fleet by threats upon our colonial empire, while her cruisers intercepted the merchant fleets coming from America and Germany, laden with the food without which we can no longer exist. There seems, therefore, to be some necessity for a reconsideration of our position.

The serious question is, whether under the circumstances of the world in which we find ourselves just now, it is not indispensable for Great Britain to sacrifice some of the enormous wealth she is annually accumulating, to effect such a connection between the labouring population and the land defences, and between the seafaring population and the sea defences, as shall not only raise the numbers requisite, but shall rouse the spirit of the people, as those of our patriotic forefathers were roused, when they determined to sacrifice all they had, rather than let the country fall under a foreign yoke.

Great Britain is now somewhat in the position that Spain held in the days of Queen Elizabeth; the great maritime and colonial power of the world. The Government of England in those days, failed to appreciate the true position and future of their country; and the Government of England of late years, has not apparently fully appre

ciated the position and responsibilities of the empire now: or they would have been more earnest in providing such an organization of the people by land and by sea, as would have ensured the fulfilment of our duties to our colonial dependencies, and would have prevented the alarms about the security of our trade, and even of our shores, to which we have been lately subject.

But there is another remarkable point of similarity between the two epochs. There are clouds appearing in the peaceful horizon that has surrounded these islands for half a century. We have been told by high authority, that the religious question in Europe is tending in directions that can hardly be settled peaceably; and a new power has arisen in Europe, whose aspirations after sea commerce are most likely to bring her into some sort of collision with the great maritime nation of the day. These aspirations may be perfectly legitimate, and may indeed be a necessity; just as it was indispensable for Spain to add Portugal and other maritime countries to her dominions, in order to carry out her mission in the rest of the world. But it is not the less a necessity for us to preserve the power placed in our hands by Divine Providence, for our mission in the world. Let us hope that if the political sky is once more overcast by these two ancient elements of discord, the Government of Queen Victoria will not, like that of Queen Elizabeth, trust so much to subtle diplomacy, and to the skill and devotion of the few soldiers and sailors in the Royal Service; but that, taking warning from that story, they will prepare the country well beforehand, so that we shall not be in danger of losing any of that dominion by land and sea, which has been growing under our hands, ever since those gallant English seamen defeated the Spanish Armada.

DETAIL OF THE ENGLISH LAND FORCES.

Army to Encounter the Enemy on the Coast.

Counties.	Foot.	Light horse.	Lances.	Pioneers.	Total.
Cornwall	2,000	140	16	..	2,156
Devon	3,000	200	..	600	3,800
Somerset	3,000	340	50	..	3,390
Dorset	2,000	40	120	600	2,760
Wilton	2,000	300	50	..	2,350
Southampton	4,000	50	100	1,000	5,150
Berks	2,000	37	10	115	2,162
Sussex	4,000	240	20	1,300	5,560
Kent	4,000	330	64	1,077	5,471
Surrey	1,000	127	8	200	1,335
Total	27,000	1,804	438	4,892	34,134

Army at Tilbury.

Counties.	Foot.	Lances.	Light horse.	Total.
Bedford	500	17	40	557
Buckingham	500	18	83	601
Hertford	1,000	25	60	1,085
Surrey	1,000	8	98	1,106
Berks	1,000	..	..	1,000
Oxford	1,000	..	..	1,000
London	1,000	35	88	1,123
Suffolk	3,000	50	200	3,250
Essex	5,000	..	..	5,000
Kent	5,000	50	100	5,150
Norfolk	3,000	..	..	3,000
Total	22,000	203	669	22,872

The Queen's Guard.

Counties.	Foot.	Lances.	Light horse.	Petronels.
London	10,000	35	88	
Middlesex	1,000	35	88	
Northampton	1,000	20	80	
Oxford	1,000	8	120	
Gloucester	1,500	20	180	
Bedford	500	17	40	
Buckingham	1,000	25	119	600
Hertford	1,500	20	119	500
Cambridge	500	6	40	
Essex	2,000	49	250	300
Kent	2,000	..	..	300
Surrey	800			
Suffolk	2,000	70	230	300
Norfolk	2,000	80	695	300
Warwick	600	12	76	
Leicester	500	9	70	
Huntingdon	400	6	20	
Worcester	600			
Total	28,900	377	2,127	2,300

Total 33,704.

Remaining in Counties.

Counties.	Foot.	Counties.	Foot.
Bedford	500	Sussex	4,000
Buckingham	600	Wilton	2,400
Hertford	1,500	Cambridge	1,000
Surrey	1,872	Northampton	640
Berkshire	1,900	Leicester	500
Oxford	1,164	Warwick	500
London	10,000	Dorset	3,330
Gloucester	4,000	Suffolk	4,239
Somerset	4,000	Norfolk	4,000
Total	25,536	Total	20,609
Of which 6,000 to be ready to join at Tilbury.		Of which 17,600 to be ready to join Her Majesty's Guard.	

Summary.

	Totals of all kinds.	
Army on the coast	34,262
Army at Tilbury	22,872
Queen's Guard	33,704
Reserve remaining in counties	46,145
Forces in Wales	9,377
Forces in Yorkshire and Durham	14,000
Grand Total..	160,360

This total consisted of the following proportions :—

Foot	..	87 per cent.
Horse	..	4 per cent.
Pioneers		9 per cent.

The foot were about half of them trained and half untrained; and about one-third of the whole were furnished with fire-arms; the remainder with pikes, bows, and bills.

Of the horse, about three-quarters were light-horse, and of the remainder about half were lancers (or heavy cavalry), and half petronels (or dragoons).

DETAIL OF THE ENGLISH SEA FORCES.

List of the English Royal Navy engaged in the Defeat of the Spanish Armada.—August, 1588.

Lord Admiral's Squadron.

No.	Names.	Tonnage.	Guns.	Men.	Captains.
1	"Ark Royal"	800	32	400	Lord C. Howard, Lord Admiral.
2	"Victory"	800	32	400	Sir J. Hawkins.
3	"Mary Rose"	600	30	250	Finton.
4	"Bonaventure" ..	600	30	250	Reyman.
5	"Triumph"	1,000	40	500	Sir Martin Frobisher.
6	"Elizabeth Jonas"	900	40	500	Sir R. Southwell.
7	"White Bear"	900	40	500	Lord Sheffield.
8	"The Lion"	500	30	250	Lord T. Howard.
9	"Swallow"	330	16	160	R. Hawkins.
10	"Dreadnought" ..	400	20	200	G. Beeston.
11	"Tramontana" ..	150	8	70	L. Ward.
12	"Foresight"	300	16	160	Baker.
13	"Charles"	70	6	45	Roberts.
14	"Moon"	60	5	40	Clifford.
15	"Bonavolia" galley	500	30	250	W. Bourough.
16	"Teittari"	200	12	100	J. Bostock.
17	"Brigandine"	45	4	35	T. Scot.
		8,155	391	4,110	

Sir Francis Drake's Squadron.

No.	Name.	Tonnage.	Guns.	Men.	Captains.
1	"Revenge"	500	30	250	Sir F. Drake, Vice-Admiral.
2	"Swiftsure"	400	20	200	W. Fenner.
3	"Aid"	250	15	120	J. Wentworth.
4	"Hope"	600	30	250	Cross.
5	"Nonpareille"	500	30	250	T. Fenner.
6	"Advice"	50	5	40	J. Harris.
	Total	2,300	130	1,110	

The tonnage, guns, and men in *italics* are only estimated from the other ships.

Sir Henry Seymour's Squadron.

No.	Names.	Tonnage.	Guns.	Men.	Captains.
1	"Rainbow"	500	30	250	Lord H. Seymour.
2	"Vanguard"	500	30	250	Sir W. Winter.
3	"Antelope"	350	16	160	Sir H. Palmer.
4	"Tiger"	200	12	100	W. Wentworth.
5	"Bull"	200	12	100	J. Turner.
6	"Scout"	120	8	66	Ashley.
7	"Achates"	110	7	60	G. Riggs.
8	"Spy"	50	5	40	Bradbury.
9	"Martin"	45	4	35	W. Gower.
10	"Sun"	40	4	30	R. Buckley.
11	"Signet"	20	3	20	J. Shirive.
12	"George ¹ Hoy" ..	100	6	30	R. Hodges.
Total.....		2,235	137	1,141	

Summary.

No.	Names.	Tonnage.	Guns.	Men.
17	Lord Admiral.....	8,155	391	4,110
6	Sir Francis Drake.....	2,300	130	1,110
12	Sir Henry Seymour.....	2,235	137	1,141
35	Grand total.....	12,690	658	6,361

The tonnage, guns, and men in *italics* are only estimated from the other ships.

*Merchant Ships engaged in the Defeat of the Spanish Armada.—
August, 1588.*

		No.	Men.	Tons.
Under the Lord Admiral	{ Ships and barks, fighting ships, and victuallers	33	1,561	
	{ Coasters, great and small, paid by the Queen	19	943	
	„ Sir Francis Drake.. Merchant ships.....	34	2,394	
„ Lord H. Seymour	{ Coasters paid by the Queen and partly by the Cinque Ports..	23	1,093	
	{ Ships and barks paid by the City of London.....	29	2,140	
	Voluntary ships, great and small.....	23	939	
Totals.....		161	9,070	About 20,000

The average size of these merchant ships was 130 tons each, but they varied from 30 to 400 tons, of which there were about half above 80 tons.

LIST OF SOME BOOKS RELATING TO THE SPANISH ARMADA.

- Bruce*.—Report on the Spanish Armada, compiled for the Government, 1798: contains many of the original reports and letters on the English preparations in the State Paper Office, and is the source from which most late writers have obtained their detailed information.
- Monson*, Admiral Sir W.—Naval tracts, written in the time of Charles I: gives details of naval operations and discussions.
- Hakluyt*, Collection of Early Voyages, written in 1599: gives some account of both fleets, and of the operations.
- Camden's Annals* of the Reign of Queen Elizabeth; written by desire of Lord Burghley: contains some account of the whole affair, but not so full as might have been expected.
- La Felicissima Armada*, a Spanish account by Jacques Boullain, Lisbon, 1588: contains full details of the Spanish Fleet. (In British Museum.)
- Expeditionis Hispanorum Angliam vera descriptio*; Rober. Adams, Authore—A. Ryther, Sculpsit, 1588.—This consists of a map of England, and ten plates of the Southern Coast, showing the position of the two fleets each day. (Bound up with the last book.)
- Survey of the Coast of Sussex* in the time of Queen Elizabeth: reprinted by Mr. Lower, Lewes, 1870.
- Barrow's Life of Sir F. Drake*: quotes much from a Spanish MS. account, which appears to be in the Admiralty.
- Froude's History of England from Henry VIII to Elizabeth*, 1870: gives much detail concerning the condition of the people of England, and of the operations; rather favourable to the Spanish.
- Mottley's History of the United Provinces of the Netherlands*, 1860: gives an animated and full account of the whole affair, but of course chiefly on the Dutch and Spanish side, and favourable to the former. He, like Froude, quotes from the original documents in Spain and the Netherlands; and from Herrera, Strada, Meteren, and Bor.
- Scott's Archæology of the British Army*, 1868: quotes from the records of the Lancashire Lieutenancy.
- Dodsley*, *History of the Spanish Armada*, written 1759: gives some details of the land and sea forces in England, in addition to those given in Bruce.

Evening Meeting.

Monday, March 1st, 1875.

VICE-ADMIRAL R. COLLINSON, C.B., F.R.G.S., Vice-President,
in the Chair.

NAMES of MEMBERS who joined the Institution between the 23rd February
and 1st March inclusive.

ANNUAL.

Robertson, the Rev. Archd., late 51st Regt.	Evelyn, C. F., Major 3rd Royal Surrey Militia.
Langhorne, A. R. M., Lieut. 52nd Regt.	Rowe, Samuel, M.B., C.M.G., Staff Sur- geon-Major.
Gaussen, Alfred W. G., Lieut. Herts Militia.	Keays-Young, H. W., Capt. 18th Royal Irish.
Wetherall, W. A., Lieut. Bombay Staff Corps.	

ON MILITARY (OR STRATEGIC) AND REFUGE HARBOURS.

By Sir JOHN COODE, Kt., M.I.C.E.

THE subject of "Military," or, as they may perhaps be more properly called, "Strategic" Harbours, which will form the chief topic of this paper, is obviously one which may appropriately occupy the attention of this Institution, but questions may well arise as to the propriety of its treatment by a civilian. It would seem, however, that a professional connection with one of the most important of the Strategic Harbours recently constructed in this country, and service as a member of the last Royal Commission on "Refuge" Harbours, have, in the opinion of your Council, constituted a sufficient qualification for the duty.

Entertaining considerable fears as to their expectations being somewhat disappointed, I have, nevertheless, at the Council's request, undertaken to deal with the subject, feeling, as I do, that whatever may be the faults and shortcomings of the paper itself, there is good reason to hope that the discussion which must follow will serve to ventilate the whole question, and thereby attract that amount of attention which its importance seems to demand.

With this explanation, which has appeared to be alike due to the Members of the Institution and to myself, I shall proceed, merely premising that I confine myself strictly to the subject of *artificial harbours*, not entering upon the defences of our Naval Arsenals, nor of the great Ports situated on large Rivers, such as the Mersey and Clyde; the requirements at these points fall more properly under the

head of local defences,—I should not, therefore, presume to touch upon them before this Institution.

What I shall have to say may be regarded as in a great degree supplemental to the able paper of General Collinson read before your Institution last year, in which the whole subject was treated in the broadest and most comprehensive manner; mine is a humbler attempt to supply information, and call attention to certain facts and considerations which have a very material bearing upon a question, the importance of which does not appear, up to the present time, to have been sufficiently appreciated.

I propose in the First place to give a brief general description of the "National" Harbours which have been constructed in modern times upon our own and neighbouring coasts, and of the defensive works by which they are protected;

Secondly. To offer a few remarks upon the conditions to be fulfilled in order to obtain a satisfactory Strategic or a Refuge Harbour;

Thirdly. To enter upon a consideration of the facts and circumstances which bear upon the question of the need which exists for a further work or works of this class, and of the selection of the most suitable site or sites for the purpose; and,

Finally, to offer such general remarks as seem to arise out of a review of the whole subject, but more especially on the Strategic branch of it.

Plymouth.

Commencing then with the most westerly of our Artificial Harbours, the first in order is Plymouth. The large embayment known as "The Sound" forms the outer anchorage for the two inner divisions of the "Hamoaze" and the "Catwater;" the Naval Establishment of Devonport is situated on the eastern shore of the former, and the commercial harbour of Plymouth proper lies on the northern shore of the latter.

The well-known Plymouth Breakwater was commenced upwards of 60 years since, the first stone having been deposited on August 12, 1812. This work consists of a detached or isolated Breakwater placed across the middle of the Sound, having its main or centre arm 1000 yards long, and an eastern and western arm or kant each 350 yards long, making a total of 1,700 yards, or 5,100 feet. The eastern extremity terminates in a depth of 6 fathoms at low water of spring tides, and the western extremity in a depth of from 7 to 8 fathoms; the general direction of the Breakwater is nearly east and west by compass.

The areas of sheltered anchorage are as follows:—

Depths at Low Water.	Areas.
3 fathoms and upwards	1,380 acres.
4 " " " "	1,260 "
5 " " " "	800 "

The cost of this Breakwater up to 1858 was £1,517,000.

80 feet deep for a portion of its length. The guns of this Fort will command the waters of the Harbour and of the West Bay.

Below the Verne on the eastern slopes of the island are some earth-work batteries mounting heavy guns, and furnished with modern appliances.

At the end of the outer Breakwater a powerful iron Fort is being constructed to guard the entrance to the Harbour. A small granite work has been placed on the extremity of the inner Breakwater to defend the Passage. This Passage is also protected by the batteries on the eastern slopes of the island, just adverted to.

Further, to deny the harbour to an enemy, and to support the Breakwater Fort, a strong casemated work has been built on the Nothe Point, above the entrance to Weymouth Harbour; this work is armed with modern heavy ordnance, protected by iron shields.

Alderney.

The island of Alderney is situated 55 miles south of Portland, 88 miles south-east of Plymouth, and 80 miles south-west of Portsmouth; it is distant about 7 miles from the coast of France, the nearest point being Cape La Hague.

Alderney Harbour is situated on the north side of the island; it is formed by a pier or Breakwater, about 1,610 yards in length, extending in a north-easterly direction from Grosnez Point, which is the westernmost headland of Braye Bay. The breakwater is built in two straight lengths, joined by a circular curve, concave to the sea, the radius of this curve being 500 yards, and its length 175 yards; the first straight length (that nearest the shore) is 1,000 yards long, the outer length being 435 yards. The depth of the original sea-bottom along the line of Breakwater increases from the shore to 130 feet below low water of the lowest tides, at the head. The outermost 600 lineal yards of this work have been constructed in water having an average depth of 105 feet below lowest tides; the original depth under the outermost 300 lineal yards of the work averaged 125 feet.

This Breakwater is exposed to the whole force of the Atlantic sea, which strikes it at right angles, the destructive power of the waves being greatly increased by the rapid tides which prevail.

The areas of the sheltered anchorage within the Breakwater are as follows:—

Depth at Low Water.	Areas.
3 fathoms and upwards	150 acres
4 " " "	114 "
5 " " "	80 "

The cost of the Breakwater up to 1872 was £1,274,000.

The island of Alderney was strongly fortified in connection with the harbour some years ago. The most important work, called Fort Albert, is situated on Mont Touraille. This fort, and also the work at Chateau l'Etoc, were designed to deny the harbour to an enemy. The numerous other forts and batteries in the island are intended to prevent a landing

in any part outside the harbour, in the event of advantage being taken of fine weather to make an attempt to do so.

Dover.

The work which has been in progress at Dover since the year 1847, and generally known as the Admiralty Pier, commences at Cheesman's Head; it runs first in a southerly direction, and then inclines to S.S.E. It is now about 2,000 feet in length, and it is satisfactory to find, by a comparatively recent decision of the Government, that it has been determined to construct such a harbour as will give complete shelter from all winds, instead of stopping the works on the completion of this western (Admiralty) pier, as had been intended. The position is far too important in a strategic point of view to admit of the bay being left unprotected from southerly and easterly gales.

It is understood that the new arm will be commenced at a point on the shore at the eastern extremity of the town, and immediately under Dover Castle. This work will run in a south by west direction, for about 3,800 feet, and then turning across the bay will run in the direction of west by south for about 2,200 feet. Between the extremity of this arm and the outer end of the Western or Admiralty Pier, when completed, there is to be an entrance 500 feet wide.

The areas of sheltered anchorage within the proposed work will be:—

Depth at Low Water				Areas.
3 fathoms and upwards	.....			170 acres
4 do.	do.	.....		145 „
5 do.	do.	.....		122 „

The cost of the western arm now in progress will, when completed, have been about £800,000; the estimated cost of the proposed eastern work is stated to be £750,000, or together, £1,550,000.

There are sea batteries overlooking the new harbour at Dover; their object is to deny the use of the harbour to an invader, for whom it would otherwise be a most convenient port of debarkation, and also to retain it in our hands as a secure base of operations, and as a coaling station for our vessels, whence they might operate either towards the North Sea, or down the Channel. Some of these sea batteries have been remodelled for the reception of the heavy artillery now used for naval and coast warfare, and at others work is still in hand. Operations are now in progress at the end of the Admiralty Pier (which, when the harbour is finished, will form the western arm of the Breakwater), for the purpose of laying the foundations for the reception of a turret to guard the harbour entrance.

Harwich.

The harbour of Harwich is situated on the shore of the North Sea, about 68 miles E.N.E. of London, and 20 miles from Colchester. The entrance to Harwich is exposed from south-east to south-west. In

accordance with the recommendation of the Refuge Harbour Commissioners of 1844, it was decided to construct a breakwater groyne, running in a straight line about 800 yards in a south-east direction from the base of Beacon Cliff to Cliff Foot Rocks, at an estimated cost of £50,000. The object of these works was to give additional protection to the port, to increase the depths of water at the mouth, and to check the advance of the Shingle Spit, at Landguard Point, which forms the north side of the entrance.

The defences of Harwich Harbour consist of a powerful fort on the spit or tongue of land known as Landguard Common, lying immediately on the north-eastern side of the harbour entrance; there is also a battery on the hill lying immediately to the south of the town of Harwich, and just at the back of the Beacon Cliff. This work and Landguard Fort command the harbour entrance and sea approaches. Within the harbour, and on the high point of land separating the rivers Stour and Orwell, there is a large, newly constructed battery, which commands the anchorage ground and the area between it and the sea.

The work at Landguard is now being re-modelled for the reception of heavy modern artillery, and is being provided with shields for the protection of the guns.

Holyhead.

Holyhead is situated at the western extremity of the county of Anglesea, in North Wales. Being in the main track of the commerce of the Irish Sea, and at the extremity of the promontory which forms the nearest point of central England to the Irish shore, its position is highly favourable for the construction of a "refuge," as well as a "packet" harbour for facilitating communication between England and Ireland. Eminently useful as it is for both of these purposes, the absence of fortifications would seem to indicate that it is not regarded as possessing any special importance in a strategic point of view. The Breakwater commences at Soldier's Point, just under Holyhead Mountain, and runs in an E.N.E. direction for a distance of 2,000 feet; it then turns to E.S.E. by a curve *convex* to the sea, and runs for a further length of 3,000 feet, when it again turns in an E.N.E. direction by a curve, which is *concave* to the sea, and is continued for a further length of 2,800 feet, the total length being 7,800 feet. The outer end is terminated by a massive head and lighthouse.

The areas of sheltered anchorage within the Breakwater are—

Depth at Low Water.		Areas.
3 Fathoms and upwards		300 acres.
4 do. do.		260 „
5 do. do.		200 „

The cost of the Breakwater and works connected with it has been £1,285,000.

Kingstown.

The harbour of Kingstown is situated on the south side of the Bay of Dublin. It is formed by two arms or piers which were commenced

in the year 1817, they are carried out nearly at right angles to the shore, where the distance between them is about 3,700 feet. These piers run first in a north-easterly direction and parallel to each other for a length of rather more than 2,000 feet, they then gradually converge so as to leave an entrance between their heads of 750 feet. The total length of the eastern arm is 4,200 feet, and of the western arm 4,500 feet.

Kingstown is used chiefly for refuge purposes and for the mail packets; it does not possess any special value as a strategic harbour. The depth of water is not sufficient for ironclad vessels of the largest class.

From the great width of the entrance and its exposure, this harbour is by no means as secure as could be desired during the prevalence of easterly gales.

The areas of the anchorage are—

Depth at Low Water.		Areas.
3 Fathoms and upwards.....		130 acres.
4 do. do.		34 „
5 do. do.		nil.

The cost of the works, including packet pier, to 1859, was £814,000.

Cherbourg.

Cherbourg is situated on the west coast of France, in the province of Normandy, and upon the northern coast of the peninsula called Cotentin, and is 58 miles from Portland Bill. It lies midway between Cape La Hague on the west and Cape Barfleur on the east, the distance between them being about 30 miles; strictly speaking, however, Cherbourg Bay may be said to be formed by Cape Querqueville on the west and Isle Pelée on the east; this small rocky island is about three-fourths of a mile long and rather more than half a mile wide, elevated a few feet above high-water mark. The distance between Cape Querqueville and Isle Pelée is about $4\frac{1}{2}$ miles, and the depth of the bay, taken from a chord line drawn between them, is about $2\frac{1}{4}$ miles.

The bay is open or exposed from east-north-east to west-north-west, the bottom is for the most part sand and fine shells, with tolerable holding ground.

The sudden contraction of the channel between the Bill of Portland and Cape La Hague, about 10 miles to the westward of Cherbourg, causes the tidal currents to run with great velocity, and renders navigation difficult and at times dangerous.

The construction of the Breakwater of Cherbourg was commenced in 1783, and was undertaken for the purpose of obtaining a harbour sufficiently extensive for the anchorage of a French fleet after the destruction of Dunkerque, there being no other refuge on this part of the French coast.

The total length of the Breakwater or Digue is 11,800 feet: it consists of two arms making an angle of 170 degrees with each other, the

salient point projecting seaward; the western arm is 6,900 feet long and the eastern arm 4,900 feet.

The areas of sheltered anchorage are—

Depth at Low Water.		Areas.
3 Fathoms and upwards	.....	1,650 acres.
4 do.	do.	1,350 „
5 do.	do.	890 „

The cost of this Breakwater was £2,675,000 sterling.

The harbour of Cherbourg is protected by numerous fortifications. In the centre of the Breakwater is a large casemated work of masonry called "Fort Central," there is also a circular fort at each end of the Breakwater, three forts along the shore of the bay, a powerful fort on Mont Roule in the rear of the town, and a series of redoubts surrounding the bay and arsenal.*

Wilhelmshafen.

The harbour and naval establishment of Wilhelmshafen are situated on the western shore of the estuary of the River Jahde on the North Sea, immediately to the westward of the mouth of the River Weser. The site of this work was purchased by the King of Prussia from the Grand Duke of Oldenburg in the year 1854. There is now an outer harbour 720 feet long by 340 feet wide covered by two piers; immediately to the westward of this there is an inner harbour 600 feet in length and 400 feet in width, there is then a harbour canal 3,920 feet in length and 216 feet in width, connecting the outer harbour with the naval establishment—a large basin 1,200 feet long and 700 feet wide. Around this basin are arranged the various workshops and stores, with three dry docks having 30 feet of water over the cills, and capable of receiving first-rate ironclads such as the "Minotaur," also slips adapted for constructing and repairing ironclads, with steam factories, &c. These works appear to have been constructed under peculiar difficulties, the excavations have been made in low swampy lands, which had first to be protected from the sea by dykes. Artesian wells had to be sunk to the depth of 900 feet chiefly through sand (with occasional layers of peat, pebbles, &c.), in order to procure water for the supply of the establishment.

The expenditure up to the year 1869 was £1,500,000. During the French war of 1870 the Prussian fleet lay at Wilhelmshafen, the enemy not venturing to approach.

The port is at present defended by an open earth battery on the right bank of the Jahde, just opposite to the harbour entrance, and by a casemated battery on the left bank; the latter is supported by two open earth batteries which cross fire with the guns of the former. The defences at present mount about seventy 11-inch muzzle-loading Krupp guns, but it is proposed to secure the harbour and establishment still further by a series of detached forts, which will completely protect it on the landward side; these forts are to be placed along the line of a creek called the Mohde, which can be inundated at pleasure.

* A summary of the foregoing harbours is given in an Appendix

It may be mentioned that Wilhelmshafen is just the same distance from Flamborough Head as Edinburgh is from London.

Before entering upon the question of the necessity for the construction of further "national" harbours, it seems desirable to offer a few remarks upon what must be regarded as the essential requirements of such works, observing at the same time that, although a harbour may leave little or nothing to be desired in the way of meeting all the conditions as respects the strategic part of the question, it may not in anything like an equal degree, be suitable as a port of refuge; if, however, it should be so, by so much the more would its value to the country be enhanced.

A *Strategic* harbour should fulfil the following requirements:—

- (a.) It should have a considerable area of anchorage ground so far sheltered as to be safe at all times, with depth of water sufficient to accomodate ironclad vessels of the largest class.
- (b.) It should be so placed as to form a good centre for the defence of some important part of the coast of the country or of the shipping frequenting it, and, if need be, as a base for offensive operations.
- (c.) It should be situated at a point suitable and convenient for observation of the movements of an enemy.
- (d.) It should possess facilities for the supply of coals and water to a fleet or squadron; and,
- (e.) If circumstances permit, it should be connected with the railway system of the country so as to afford ready means for the concentration, embarkation, and disembarkation of troops, and for the supply of military stores and provisions.

To an insular country like our own, ever, of necessity, dependent upon the Navy as its first and chief line of defence, a judiciously placed harbour affording these advantages would greatly increase the power of any fleet or squadron, and, conversely, the effective power of any naval force would be seriously diminished when employed on a coast where no such harbour might exist.

A *Refuge*, in common with a *Strategic* harbour, should possess—

- (a.) Ample area and depth of sheltered anchorage, safe at all times.
- (b.) It should be so situated as to give shelter during storms at a part of the coast where such shelter is most needed, and where it may be available to the greatest possible number of vessels trading along it.

Facility of ingress and egress, and good holding ground, are assumed as essentials in either case, and it is to be regarded as a great desideratum that the elevation and configuration of the surrounding shores should be such as to be adapted for the construction, at a moderate cost, of efficient works of defence, which would at least protect the shipping lying within, and to some extent command the approaches.

Having so far cleared the ground as to show what are the essentials

of a "national" harbour, whether regarded from a "strategic" or "refuge" point of view, we come to the two-fold question,—

Is this country at present in need of such a harbour or harbours? and if so, where is the need the greatest?

To the first branch of this question, I answer emphatically "yes;" and to the second I venture to reply with equal emphasis, "*on the north-east coast of England.*"

That these may not be characterised as mere dogmatic assertions, I shall now proceed to state the grounds on which they are based.

It needs no more than a very superficial acquaintance with the eastern coasts of the country to recognise the fact that the district comprised between the rivers Humber and Tyne—of course, including both of them—comprehends all the principal commercial and industrial "centres" of the eastern part of England. The magnitude and importance of the trade and commerce of this district are such that they may with truth be said to bear no inconsiderable proportion to the whole of the United Kingdom.

Through the courtesy of a friend resident in the locality, I have obtained the following particulars of the value of the *mining and manufacturing products* of the district known as that of the "north-eastern ports," i.e., of the towns situated on and immediately surrounding the rivers Tyne, Wear, and Tees, including the two Hartlepoons, but exclusive of the Humber, for the year 1873. The figures are large, but from collateral evidence of their accuracy, I feel assured that they may be accepted as substantially correct:—

	£
Coals	10,600,000
Metallurgical products, chemical manufactures, glass and clay wares, machinery, &c.	22,900,000
Iron and timber, shipbuilding, and marine engines	5,450,000
	<hr/>
	£38,950,000

Thus giving a total which closely approximates to £40,000,000 sterling per annum.

From the Board of Trade "Returns of Navigation and Shipping," it appears that the value of the *exports* alone of the *produce of the United Kingdom* from the ports on the Tyne, Wear, and Tees, including the Hartlepoons, amounted in the year 1873 to £14,985,000, or practically to £15,000,000 sterling.

According to the Secretary of the Newcastle and Gateshead Chamber of Commerce, no less than 105 vessels were built on the *Tyne alone* in the year 1873, their net register capacity amounting to 64,933 tons. In their construction upwards of 40,000 tons of iron were used, and employment was given to about 7,000 men and boys, whose wages amounted to about £400,000. It may be remarked that Her Majesty's iron-plated vessels "Defence," "Swiftsure," "Triumph,"

and "Ceberus," and the Indian troop-ship "Jumna," were built on the Tyne.

The men employed in the collieries of the Newcastle and Durham coal fields in 1873 numbered more than 90,000, their wages amounting to £7,500,000 sterling.

These figures will suffice to show the extent of the commerce of the north-eastern ports between the Tyne and the Tees, and the immediately surrounding district.

The trade of the ports on the Humber has of late years assumed large and rapidly increasing proportions, not alone is its extent remarkable, but the value is no less striking; for it appears upon examination of the official returns, that the *Exports of the "Produce of the United Kingdom"* from the ports on *this river alone* amounted during the year 1873 to £37,967,000, or practically £38,000,000 sterling, nearly two-thirds of this (£22,750,000) consisted of cotton and woollen manufactures of various kinds.

These last figures may be commended to the notice of the men of Manchester, of Bradford, and of other centres of our cotton and woollen manufactures, whose goods find their outlet through the Humber, and whose interests in this question are therefore more deeply concerned than they are probably aware of.

Grouping together a few of the more important facts relating to the trade of that portion of the coast comprehended between the Humber and the Tyne (both inclusive), it may be noticed that the vessels which cleared from, and entered at, the ports within these limits in the year 1873 reached the large number of 70,747, amounting to upwards of 16,460,000 tons (including those trading coastwise with cargoes, but exclusive of those in ballast), being equal to nearly *one-fifth* of that of the United Kingdom, and *more than one-fourth* of that of the whole of England.

As regards the vessels which "*cleared*" within the limits named in the year 1873, their tonnage amounted to between 10,000,000 and 11,000,000 tons, or practically the same as that of the *ports of London and Liverpool united*. The value of the "*exports of the produce of the United Kingdom*" from the ports within the same limits (Humber and Tyne inclusive) amounted in the year 1873 to £53,000,000 sterling, or between *one-fifth* and *one-fourth* of the value of the same exports for the whole kingdom.

Having regard to area and number of inhabitants,—extent and value of mineral resources,—variety and importance of industrial interests,—and general commercial activity, the district immediately surrounding these north-eastern ports and rivers may be safely said to be unparalleled; it is certain that upon no part of the coasts of the United Kingdom, and probably nowhere else in the world, will an equal number of vessels, and a corresponding amount of tonnage, be found upon the same length of seaboard.

An inspection of a chart of this part of the north-eastern coast shows at a glance that the most salient point is the promontory known as "Flamborough Head;" this forms the southern limit of the large indent of the coast known as "Filey Bay," which,—although not

exactly so,—is practically midway between the centre of the Coal Ports and the Mouth of the Humber; it is also just midway between the Mouth of the Thames and the entrance to the Firth of Forth. There is a further peculiarity about this particular part of the coast that,—owing to the projection of Flamborough Head, and the ample depth of water close in shore,—all coasting vessels hug the land very close at this point, whilst from the peculiar configuration of the coast, vessels bound to the southward frequently meet with baffling winds which compel them to beat about the Head for a considerable time, and in the event of bad weather coming on, are not uncommonly driven back to, or even beyond, their ports of departure, many being wrecked ere they can reach a port of safety. Moreover, all vessels engaged in the very important trade between the Humber and the Baltic make Flamborough Head their “point of departure” when outward bound, and endeavour to make it their “landfall” when coming home. From these several causes combined, there is at this part of the coast an almost daily concentration of vessels engaged in home and foreign trades, and to an extent such as will not be found to exist in any other part of the Kingdom. Filey Bay is, therefore, admirably placed as a site for a “Strategic” and “Refuge” Harbour, not only for the north-eastern seaboard of the Kingdom, but also, and especially, for the great commercial centres to which reference has already been made.

And it is not only in respect of *situation* that this Bay is so well adapted for a National Harbour, but it possesses all the requisites in the way of area, depth of water, good holding ground, facility of ingress and egress, proximity to the northern steam coal field—with which it is connected by railway—stone in the adjoining cliffs, good fresh water, and such elevation and configuration of the surrounding shores as to admit of the ready construction of works of defence.

The capacity of a Harbour at Filey would depend mainly upon the amount of money appropriated for its construction; the form and size of the Bay are such that it would admit of a Harbour of any reasonable extent being formed there. It may be sufficient here to state broadly that for a much less amount than that proposed to be expended at Dover, a Harbour may be formed at Filey with three times as great an area of sheltered anchorage, and with greater depth of water.

After close and careful inquiry, Filey Bay was especially recommended by the Royal Commission on Harbours of Refuge, in 1859, as the most eligible site for a national harbour on this part of the coast.

If it be desired to erect a new convict prison, and it should be decided to employ convict labour upon a harbour at Filey, a very suitable site for the necessary buildings may be found in the immediate vicinity of the quarries that would be opened for the works.

The subject might have been amplified, but enough has doubtless been said to demonstrate the necessity for the immediate construction of at least one “Strategic” and “Refuge” Harbour on the north-east coast of England.

To judge from the far too great indifference with which this subject has been regarded in high quarters for some years past, it may, per-

haps, be too much to anticipate the immediate undertaking of more than one such work, but there can be no doubt that the claims of the Bristol Channel for the construction of a national harbour will rank next in importance, and there can be as little question that there is no site in that channel which combines in an equal degree the essentials for a Strategic and Refuge Harbour as that of the eastern side of Lundy Island; this was also recommended as an eligible site for a national harbour by the Commission of 1859. Situated at the mouth of the Bristol Channel proper, and nearly in the middle of the entrance, it is in advance of the important coal and iron ports and districts of South Wales, and therefore admirably placed for the shelter of any naval force intended for their protection, whilst it would afford a refuge for the mercantile marine on a dangerous coast.

As in the case of the north-east coast, so in that of the Bristol Channel, it is not *alone* the large number of vessels and their tonnage, or the simple *money value* of the trades concerned, which have to be taken into account, but the *character* of the chief items—*coal and iron*,—a material restriction of which in time of war will prejudicially affect the country generally to a far greater extent than that of any other branch of commerce of equal magnitude or value.

It is now proposed to offer a few remarks on the subject generally, it being understood that they are intended to apply mainly to the case of the north-east coast of England, and more especially to that portion of it which lies between the Humber and the Tyne.

In the first place it may be remarked that the reasons which existed for the recommendation by the Royal Commission of 1859 of the construction of a National Harbour of Refuge at Filey, have not diminished in force in the interim, but rather the contrary, seeing that the trade of the district has at least doubled itself within that period; and that the wrecks and casualties on the coasts of the United Kingdom, which numbered 1,051 for the average of 5 years, ending 1857, numbered 1,779 for the average of the 5 years, ending 1872.

It is a well ascertained fact that more wrecks occur annually on the east coast than any other part of the kingdom, and it is also a fact that of these wrecks, two-thirds occur on that part of the coast which lies between the Fern Islands and Flamborough Head.

It is sometimes said that the introduction of steamers (and especially of iron steamers) will give almost perfect immunity from wreck. To this it may be answered, that of the 1,206 casualties on the coasts of the United Kingdom in 1873, 169 occurred to steamships, and of these 169 steamers, no less than 142 were built of iron. Again it has been urged that the conveyance of coals by railway from the north to London is rapidly superseding transport by sea. The best answer to this is to be found in the official return of the Registrar of the London Coal Market, according to which it appears that whilst the quantity of coal brought to London by railway and canal was 462,800 tons *less* in the year 1874 than in the year 1873, the quantity brought by sea in 1874 was 62,000 tons *more*.

It thus appears that, so far as the question of refuge for the Mercan-

tile Navy is concerned, the need for a harbour on the north-east coast is greater now than it was in 1859.

It now becomes necessary to adduce a few leading considerations which bear upon the question of the necessity for establishing a "Strategic" Harbour on the coast between the Humber and the Tyne.

A cursory glance at the chart suffices to show the remarkable difference in the number of strategic and well-fortified harbours on the south coast as compared with the eastern seaboard of the Country, along the whole of which, northward of Harwich, there is not a single harbour of this class and not a single fort adapted as a work of defence against modern artillery. It is needless here to dwell upon the reasons which have operated to bring about the construction of so many Strategic Harbours in the English Channel within the last 60 years,—the period which embraces the execution of the breakwater across Plymouth Sound; but the existence of the war-ports on the opposite shore of the North Sea and on the Baltic, and the remarkably rapid development of the German and Russian Navies, are facts which cannot be ignored.

Only within the last few weeks the semi-official *North German News* contained an article from which the following is an extract:—

"In remodelling our naval designs in April, 1873, and laying down a new plan for the construction of ships, we intended to protect our commerce, defend our shores, and develop our powers for assuming the offensive at sea."

Is there not here an example worthy of—if not demanding—thoughtful consideration by the rulers of England as an insular country with such vast and vital interests dependent upon the complete command of the sea?

Our Navy is universally—and obviously must ever be—regarded as our *first* line of defence; but it may be asked what have we at present to rely upon as our *second*? and does not a calm consideration of the facts call for the prompt adoption of all reasonable measures calculated to give the utmost strength and efficiency to our first and all-important arm? Further it may be asked, how can this be done so effectually and economically as by providing a base for naval operations at a critical point? Without such a base, the operations of any naval force must of necessity be materially weakened and restricted.

Much reliance is placed upon the numbers and sizes of our modern ships of war; but granting to the fullest extent which the facts will warrant the present superiority of the British Navy as compared with that of any other country in point of numbers, sizes of ships, and "weight of metal," it must nevertheless be borne in mind that a mere numerical comparison by no means constitutes such a ground for satisfaction or security as may at first sight appear. Setting aside for the moment any question of adverse combination, this comparison will fail if we take into consideration the magnitude of our maritime commerce as compared with that of any other country,—the extent to which (from our insular position and large population) we are dependent upon foreign countries for our food supplies,—the great length of coast line to be protected at home—and the number and importance of our

colonies and possessions abroad. Bearing these facts in mind, and giving to them no more than their due weight, we must surely be led to the conclusion that every possible step should be taken for increasing the efficiency of the Navy as the first and most important defence of the country.

The apathy and indifference of the mercantile community can only be accounted for on the supposition that they are so engrossed with commercial pursuits that—in so far as they give to such matters any consideration at all—they place their reliance upon the Government for doing all that is really requisite, whilst there is reason to apprehend that, on the other hand, the Government, in the absence of any representations or pressure from without, have hitherto allowed matters to drift along to a point at which the subject assumes an aspect of such importance as to demand prompt and grave consideration.

What is sometimes and not inaptly designated the "Ostrich" policy, may be very "comfortable," and very economical as *long as it lasts*, but it indicates a state of things from which it is by no means impossible that those who indulge in it may be somewhat suddenly and rudely awakened. There seems to be an opinion among a by no means inconsiderable section of the community that war is a question which rests with England alone. Those who adopt this view must have wholly overlooked the fact that circumstances *may* arise which would put it beyond the power of this Country to avoid this much-to-be lamented climax. It must never be forgotten that it is not beyond the compass of possibility that circumstances may occur in which war might be forced upon England.

In an article which appeared in the leading journal of this Country only ten days since, it was said, "Dreams of ideal peace and political alliance rest on much the same foundations as dreams of conquest and of war; they are speculations and nothing more * * * Of all calculations, those that depend on the continued accord of powerful neighbours are the least to be relied upon" * * *

The same article says:—"To our apprehension the history of Europe for the last thirty years proclaims one warning more loudly than all, more loudly than even the fickleness of fortune, and that is the inconstancy of man." Of the truth and force of these remarks there can, I imagine, be no possible doubt or question.

In these days of such vast armaments and such rapid changes, who, I would ask, will be so bold as to say that war is for us impossible? Let us hope and pray that it may be averted, but we should face the possibility and act accordingly.

These several considerations lead to the inevitable conclusion that our means both for *defence* and for *offence* should be so increased as to meet the circumstances of the times, and that further protection should without loss of time be provided for what are at present the most vulnerable and vital points of the Country, combining with such protection the best means of carrying on offensive operations, if the occasion should unhappily arise.

It is submitted that these objects cannot be attained more effectually and economically with respect to the most important part of our sea-

board than by the construction of a National Harbour on the north-east coast. Such a work would become to the North Sea what Portland is to the English Channel, inasmuch as it would combine, in at least an equal degree, advantages to the mercantile marine in time of peace, and to the Royal Navy in time of war. It would form a permanent and substantial addition to the national defences, and, as such, would constitute a great and additional safeguard for the Country.

Reason must convince us, and experience frequently reminds us, of the wholesome truth which lies embodied in the maxim—

"Si vis pacem para bellum."

Lieutenant-Colonel CROSSMAN, R.E. : I came here to-night not knowing what Sir John Coode was going to say, but intending to advocate what he has advocated so ably, viz., the establishment of a harbour on the north-east coast. He has, however, said so much in favour of it, that it would be impertinent in me to say anything more in its favour. Although Sir John Coode made an excuse for attending here as a civilian, we ought to be much obliged to him for coming to speak of matters that he knows more about than almost anybody else. What he has said is well worthy of the attention of this meeting. I would merely say that as, in a strategic point of view, we have got harbours along the south coast from Plymouth to Sheerness, I think the Government ought to consider a little more before they expend so much money upon a harbour at Dover instead of upon one on the north-east coast of England, where it is so urgently required.

Captain ROSEASON, R.N. : I am sure we must feel indebted to Sir J. Coode for the very able paper that he has read to this Institution, and I believe, following, as it does, the excellent lecture by my friend General Collinson, it never could have been delivered at a more opportune time. I have not come here in any way to controvert a single word that Sir J. Coode has read to the Institution, but simply to draw attention to what the Government are doing in the matter of strategical harbours at the present moment. I shall not enter into any controversy as to whether the formation of a harbour at Dover, which is now on the eve of being carried into execution, is a judicious Act of the Government or not, but I have to deal with it as a fact that the Bill is framed, that the money is about to be voted, and the whole arrangements of the Government are complete for making a strategical harbour there. I shall presently read to you from a paper just laid before Parliament the line of conduct the Government has agreed upon with regard to this measure. This Parliamentary paper, dated February 5th, contains the first intimation given by Government of the Bill which they are about to introduce. The Bill itself proposes to form a harbour at Dover. At present you all know there is only an Admiralty pier. That pier affords a very incomplete protection to vessels entering the roads, because it only yields protection from the western winds, and not from the southernly and easternly winds. The plan that the Government has adopted is the one that I sketched out about three years ago. On arriving at Dover from the Continent, I called on my friend General Collinson, and found lying on his table a plan of Sir John Hawkshaw's for making a harbour for the Harbour Board and the Railway Companies. On inspecting the plan, I stated that if it were carried into execution it would ruin one of the finest sites for a strategical harbour in all England. Remember, the strategical value of a harbour may change altogether according to the political circumstances of the country. When the strategical value of Dover was greatest, was during the time when hostilities were frequently carried on with France. The political changes that have taken place may now raise Germany into a very prominent and formidable naval power, and therefore it is morally certain that at some future day the Government will adopt the proposal for a harbour at Fily. The late President of the Board of Trade, Mr. Chichester Fortescue (now Lord Carlingford), said in the House, when opposing a suggestion for forming a harbour at Fily, that if ever Germany rose to any prominence as a naval power, the Government would be prepared to embark in the necessary expenditure to form

a port there, but at the present moment he was not prepared to introduce such a measure for mere commercial purposes. For it must be regarded not merely as a question of a harbour of refuge, but as a strategical port which would render it necessary to fortify it, to erect barrack accommodation, and to make railway communication in connection with it. Therefore, when you speak of the expenditure necessary to form a harbour, you must consider those additions to it which the formation of barracks, docks, and railway communication entails. Now, Dover, on the other hand, has all these advantages already. It has two railways running into the town, placing it in direct communication with our large arsenals at Woolwich, Chatham, Sheerness, Canterbury, and Shorncliffe, and other military depôts. All these advantages are clearly shown in the strategical map which is published in my pamphlet. At the present moment the Government has a Bill already framed, but as the details are not quite agreed upon, it is not yet before the House. The paper which I hold in my hand, however, now laid on the table of the House of Commons, before alluded to, gives the leading features of the Bill in the following words:—

"With reference to your letter of the 25th February last, and to my reply dated the 18th May, I am now commanded by the Lords Commissioners of the Admiralty to acquaint you, for the information of the Board of Trade, that at a meeting held on the 21st inst., at which the Treasury, War Office, Board of Trade, and Admiralty were represented, the following points with reference to the extension of Dover Harbour came under discussion, and were agreed to, namely:

- "1. That the works shall be constructed by the Dover Harbour Board.
- "2. That the whole of the money required is to be lent by Government.
- "3. That two-thirds of the loan is to be repaid.
- "4. That the power be given to the Dover Harbour Board to charge dues on ships.
- "5. That the Admiralty Pier be vested in the Dover Harbour Board.
- "6. That the constitution of the Dover Harbour Board be altered by the addition of Government officers thereto."

The object that the Government have in view is not merely to make a strategical port, but to develop and increase the facilities of communication with the Continent. The Government, moreover, are determined that the harbour of Dover shall be made largely to contribute to reimburse the expenditure. The full amount to be asked from Parliament for these works is £970,000. The engineers contemplate the completion of the harbour in eight years, but in less than half that time great part will be available; the expenditure is expected to amount to £120,000 each year, giving as a free grant £40,000 of that sum, and charging £80,000 to the Harbour Board, to be repaid to the country when the revenue of the port will admit. The bulk of the money to be advanced by Government will be as a loan, not as a gift. At the same time it is proposed in the Bill that bye-laws shall be printed, to enable the Harbour Board to levy a passenger tax of either 6d. or 1s. a-head. At 6d. a-head at the present moment such tax will yield about £6,000 a-year, and at 1s. of course £12,000. Therefore the passenger tax alone will nearly double the revenue of the port of Dover at the present moment, for the whole revenue at present does not exceed £15,000 a year. The area enclosed will be about 350 acres, which will enable the Harbour Board to raise a large revenue from harbour dues, for all shipping entering the heads will have to pay. The distinction between the proposition made by me to the Government and that which was made by the Royal Commission in 1844, is very marked. The Royal Commission proposed that a harbour of refuge or free port should be constructed at Dover. The harbour proposed by me, and which is adopted by the Government, will not be a free port. The difference is transparently clear; the State is merely called upon to loan the money to the Dover Harbour Board, not to make a free gift of it. Being a strategical port, every ship that enters the heads will be forced to contribute to the maintenance of the port; thus a very large revenue will accrue in a few years, I conceive £40,000 or £50,000 a-year will be earned by the Harbour Board towards paying back to the Government both the principal and interest of the sum lent to them. If I understand the proposal correctly in respect to Folkestone Harbour, it is to be a free port, just like Holyhead, where ships entering contribute nothing. There is another material benefit that will flow from the construction of this harbour. At present no policy

of insurance can be recovered by any vessel lost at Dover, as it is notoriously an unsafe anchorage. Having requested the Lord Chief Justice of England, Sir Alexander Cockburn, to join the Royal Dover Yacht Club, he most emphatically declined to do so, stating that the Court of Queen's Bench had settled the question as to the nature of the anchorage; and he added, that it was a national disgrace that the entrance gate to England should be still left in such a state. You will observe by the map that the Downs is only six miles from Dover, therefore Sir J. Cooke is perfectly correct in saying that, having that natural advantage, an additional harbour of refuge at Dover is not so much needed as at Filey. I perfectly agree with him in that respect, and that there is a great demand for a harbour at Filey. But the question is, will the Government by these acts concede the immediate necessity of the one but not the other? It must be remembered that towards this port they have already expended about £750,000 on the Admiralty Pier at Dover, which yields little or no return to the nation in money; when, however, the new harbour is finished, I have no hesitation in saying that in about 50 or 60 years, not only will the million be repaid to the country, but the interest also of the sum that has been expended upon the Admiralty Pier will be fully realised and the Harbour Board be out of debt. It is important to bear in mind that Government pays 1 per cent. less for borrowed money than public companies, and that 1 per cent. will, at compound interest, extinguish any amount of capital in about 54 years. I look to the income of this harbour at Dover, from the proceeds of the passenger traffic and the large increase in the trade of the town, to liquidate not only the loan that is now proposed, but all the principal and interest of the money that has already been sunk. I wish Sir J. Cooke perfectly to understand that I am fully convinced that the view he has taken of the value of Filey is correct; but I was pleased to see the vast trade and mining interests involved, for I was not conversant with all their details, but after having carefully perused the able paper by my friend General Collinson, I saw the enormous traffic that was passing through the narrow Straits of Dover, and clearly perceived that a strategical harbour for the defence of that vast trade was an absolute necessity, and therefore I shall continue to urge on the Government the importance of completing as early as possible this important national undertaking.

Admiral Sir HENRY CODRINGTON, K.C.B.: May I ask Sir J. Cooke to inform the meeting what he considers will be the approximate cost of a harbour such as he proposes at Filey Bay? Are there the means of constructing a harbour cheaply there? I do not ask for any detail, but giving it roughly, in comparison with Portland, which is a monument of his skill, what would be the expense of a first-class harbour at Filey? I remember a proposal many years ago for a harbour at Redcar, where the rocks afforded some natural advantages, but I have not any information about Filey. I can quite see that a first-class harbour there would be most advantageous to us. Passing now from the subject of large harbours, and referring again to the Channel, where we seem tolerably well protected with large harbours, it strikes me we have too much forgotten the small harbours. An enemy attacking England will, I should imagine, find our large harbours sufficiently well protected, at first, at any rate, and to be too tough a nut for him to crack in his first operations, but if he could discover any place between those large harbours where he could make a lodgment, before we could accumulate forces sufficient to oppose him, he would then have a sort of gate into England, and perhaps we should find some difficulty in dealing with him then. Our forces are mostly massed at the large ports, but what is to become of the small ports, which were so advantageous in previous days in making the commerce of England, and in carrying it up into the interior? I can speak from personal observation of two or three that I have frequented in yachting, and it grieves me to see the way in which they have been allowed to go to the bad and silt up, for want of the commonest energy to keep them clear, and they have been very largely trenched upon by railways bringing down mining produce, to the exclusion of what is necessary for us in war, namely, gunboats. We want a force to be on the spot wherever an enemy may attempt to set his foot, so that he may be prevented from making a lodgment until we can bring down the military from our military centres.

Captain HOSKISON: Perhaps Sir J. Cooke is not aware of or his attention has

not been directed to, the new Bill that the Chancellor of the Exchequer has brought into Parliament, which will no doubt greatly further these works. I have reason to believe that that Bill has grown up out of this new harbour at Dover. The fact is the Government has not the funds at their disposal. The Loan Commissioners had only the power to loan £300,000 for all public works all over England; but the new Bill will enable the Government, at their discretion, to bring forward every year any votes which they may judge necessary, whether in connection with the Board of Trade, or any other department of the State; so that if the Bill passes, as I expect it will in a very short time, it will not be necessary for the Government to limit the loans to £300,000, or even £1,000,000.

Vice-Admiral OMMANNEY, C.B., F.R.S.: I think from what I gather from the paper, there is no question of rivalry between Dover and Filey. I think after the very exhaustive reasoning and clear case that Sir J. Coode has presented in favour of a port for the north-east coast, his proposal must receive universal support, and that the influence of the paper that has been read here to-night will extend further than the ears of those who have listened to it. There is no doubt that harbours of refuge are a great source of wealth and strength and commercial prosperity to this country, and I should like to ask Sir J. Coode whether he has ever directed his attention to the formation of a harbour in Mounts Bay. I dare say all seamen when off the Lizard have frequently seen hundreds of merchantmen beating about there, who would have been very glad of a harbour of refuge. The harbour at Falmouth is very circumscribed, and with no great depth of water. I have often, when off the Lizard, thought what an important thing it would be to have a harbour in Mounts Bay. Those acquainted with Mounts Bay will know the ledge of rocks extending from Mousehole Point, which forms a famous foundation for erecting a pier, second only to that celebrated work of Sir J. Coode's at Portland, and I should like to ask him if he has ever directed his attention to that place. I cannot sit down without raising my humble voice in support of his arguments in favour of a port at Filey.

Major-General COLLINSON, R.E.: I am very glad to take this opportunity of expressing my gratification that we have had the benefit of the skill and experience of a well known civil engineer like Sir J. Coode, to assist us in drawing the attention of the public of England to this important question. I hope it will never go forth from this Institution, that there is any question of rivalry between these two places, Dover and Filey. Sir John Coode has shown us very strong commercial reasons in favour of a harbour of refuge on the north-east coast, and he has also shown us some good reasons why it should be a military harbour for the protection of our trade there; and Captain Hoseason has shown us very clearly what would no doubt be an important point with the House of Commons, namely, how they will get a revenue out of the harbour of refuge at Dover; but the fact is, as the commerce of this country increases, so must the public pay for the protection of that commerce. If, for instance, iron mines should be discovered upon the north coast of Scotland, a great town would arise there, and we should have to make a harbour of refuge there, with places for our war vessels to coal at, and forts to protect our trade there; and if the commercial people of England will not pay the sum necessary for that protection, some day or other they will find that they may not only have to pay a great deal more than they would have to pay now, but may stand a chance of losing the whole trade altogether. I wish to put upon record here two circumstances that have come under my notice lately, to show the importance of increasing our means of assistance to our men of war in time of warfare. They were mentioned to me by a naval Officer, whose name I am sure will always be received in this Institution with great respect—Admiral Sir William Martin. He told me that about the year 1858 or 1859 the superintendents of the dockyards were called upon to report how soon they could make ready for war the ships lying in ordinary and in the first and second class Reserves. I must allow that since that date very great additions have been made to our dockyards at Portsmouth and Chatham, but we must remember that the size and draught of our war ships has also increased. At that time there was a rumour of war flying about, and Sir William Martin, who was then Superintendent of Portsmouth Dockyard, went into very close calculations, and found that, applying the whole force of that dockyard (leaving out all the ordinary repairs and construc-

tion of new ships), it would have taken him two years to get the ships ready. He ascribed that not only to the low condition into which the dockyard establishment had been allowed to get, but also to the want of wharfage and basin accommodation. He expressed himself very strongly indeed about the want of large wharves with accommodation for men-of-war in war time, with considerable depth of water at all times of the tide. That is still a great defect in our great dockyards. He told me that at that time it was considered a very great feat to take four or five men-of-war into Portsmouth Dockyard, get them into dock, and out again, in a couple of tides; but during war we must recollect that time is the essential object in these days of steam, and we should probably have four or five times that number of ships coming to a naval station and requiring at least to lay alongside a wharf. We should also require hundreds of yards of wharfage, with deep water at all times of the tide, at several points along the coast, for the embarkation of stores and troops. We have got really very little of such accommodation now; this shows that even now, with all the alterations that have been made, it is most important to increase the wharfage in still water at different parts of our coast, where the commercial interests require it, and the strategic importance of the place demands it.

Captain HOSEASON: I should like to ask Sir J. Cooke if he would favour us with his opinion on the subject of harbours silting up in any way. In modern days does that cause any practical difficulty in the construction of a harbour; that is to say, do steam dredges afford all those facilities which are necessary to keep such harbours clear, however fast the silt may accumulate on the coast of England?

Captain HORTON, R.N.: I beg to venture a remark as to the additional importance of the construction of a harbour at Filey, from the circumstance that, as I believe, between Harwich and the Frith of Forth there is not one estuary or harbour available for our modern ships of war. We have some old training ships in the Tees, Tyne, and Humber; but I believe I am right when I state that there is not one harbour available for a ship of large size, coming in from sea under circumstances of difficulty, or in fact under any circumstances whatever.

Sir J. COOKE: What I have to say will be exceedingly brief, and I will endeavour to reply as far as I can in the order in which the speakers have addressed the meeting. As there seems to be an entire concurrence between Major Crossman and myself, I have nothing to say with reference to his remarks. As to the next speaker, Captain Hoseason, at first I thought there was an endeavour to set up a little rivalry between Dover and Filey, but I am happy to find that such is not the case. He spoke of the importance to a harbour of good communication, and I may say as regards Filey, that there is railway communication north, south, and west. Eastward, of course, there cannot be any. As regards the new Bill introduced by the Chancellor of the Exchequer on the subject of loans, I am quite aware of its existence, but it appears to me to be neither more nor less than a measure for the enlargement of the powers of the Loan Commissioners, and I cannot see that it touches this question in any way. If a strategic harbour is required, I do not at all see how you can expect to make it a matter of profit to the country. Why should a harbour, such as I say is wanted on the north-east coast of England, be made a question of revenue more than the harbour at Plymouth or at Portland? They are essentially national questions, and as such I cannot agree with Captain Hoseason, that the new Loan Bill will affect the decision of the Government. The last question was with respect to the difficulty of silting up. Well, if a harbour does silt up, there is only one remedy—that is the remedy which he pointed out—of dredging. If a national harbour, wherein you require something like 5 or 6 fathoms of water, has to be dredged, it is a very formidable business, but it can be done. It is simply a question of money. Certainly, there would be no such risk at Filey. In answer to Admiral Sir Henry Codrington, the cost at Filey, as I said in the paper, is just a question of the size of the harbour you wish to make; but such a harbour as I pointed to—which would necessarily be larger than that recommended by the Commission of 1859, simply because our ships have grown enormously since that time, and therefore to accommodate the same number of vessels a harbour must be very much larger than was required at that time,—such a harbour as I have pointed to would cost in round numbers, without going minutely into the estimate, about £1,000,000, and for that sum you would have a harbour, the deep water area of

which, would be from two to three times that of the proposed harbour at Dover. There is good stone in the cliffs immediately adjoining. The question of the preservation of small ports is a very important one, and, as accessory to a large harbour, I think it is very desirable that something should be done, perhaps more in the direction of giving accommodation for gunboats, in order to protect the coast until a more powerful force can come up; but I fancy Sir Henry would hardly like to see the whole extent of that coast, from Dover to the Frith of Forth as it now is, without some centre or base for naval operations—what I may call a naval centre in contradistinction to the military centres that have been, or are about to be, established by the Government in different parts of the country. I regard a strategic harbour as nothing more nor less than a naval centre to form a base of operations. As Admiral Ommanney very properly remarked, this is not a question of rivalry between Dover and the north-east coast. I am very happy to see the Government have decided upon making a harbour at Dover, which will supply what is evidently a very great need. As regards the question of Mounts Bay, I have looked at that, and a most desirable site it is in many respects; being near the Land's End, it is, in some sense, of value strategically, but I am afraid, until the greater needs are supplied, there is very little hope of getting anything done there. The Government will naturally say, "For that part of the coast Falmouth harbour is available." It is obvious that until you have supplied the greater need the lesser must stand by. There really is not northward of Harwich a single port or harbour along our eastern seaboard where anything like a small squadron of ironclads could anchor and form a centre for naval operations. Looking at the vast trade of that coast, of which I have given the details in this paper—the figures are very large, but I am confident of their accuracy—it does behove the Government speedily to take some steps to apply a remedy. It may be said, perhaps, it is not very wise to call attention so prominently to this very important trade on a vulnerable part of our coast; but I think there is nothing in that objection, for you may be very well assured that these things are as well known in some quarters on the continent of Europe as in England. Perhaps I may mention a little incident which may go far to confirm what I say. When I was on the Continent, just after the close of the Franco-German war, I travelled with a very intelligent Officer attached to the staff of one of the German Generals, and in the course of conversation I found he had a most extraordinary knowledge—not a general knowledge, but a knowledge in detail—of all the principal French fortresses. Of course I could not test the accuracy of his facts, but it was evident that he had at his fingers' ends, so to speak, the fullest information as to all the great French fortresses. I could not help remarking that I was struck with his great knowledge on these points, and I certainly shall not very soon forget the quiet smile with which he said, "I think I ought to know something about them; I had 'three years during which my duty was to do nothing else.'" I thought that a very significant fact, and although some may consider it a little injudicious to speak of the state of our trade on the north-east coast, and the weakness of the country at that point, I do not think so, for I am satisfied these things are as well appreciated, if not better, abroad than they are at home.

The CHAIRMAN: I think Sir J. Coode had not the advantage of being here last Friday week, or he would have heard something about the "Intelligence department" in a lecture which was given to us on that occasion; and I have no doubt that the French and German and Russian Governments are in possession of perhaps better information than many of us who are here at this moment. I would allude in a few words to the necessity of a harbour on the east coast. From my vocation as an elder brother of the Trinity House, I am continually moving up and down the coast, and I may allude to one or two points which have come especially under my notice. In the first place with reference to the coaling stations, Harwich would not take a large ironclad. It is a 16 feet harbour at low water, and there is only 12 feet rise and fall, and consequently with the narrow turn going into it, it is not fit to be used for a heavy draught ironclad. In the olden time Hollesley Bay was much frequented by our ships, and it forms a good roadstead, and is easy of access. Then going up the coast we come to that celebrated roadstead Yarmouth, and I regret to inform you that the changes in the sands opposite that town have been so great during the last two years, that it is not fit for an ironclad to go into from the

southern side. Formerly they could approach it through the Cockle Gateway, and go out through St. Nicholas Gateway; but within the last year St. Nicholas Gateway has shoaled, and when the Fleet went in the other day they were compelled to go out by the Cockle Gateway, and even here there are patches of 23 feet dispersed over it, which, with only 6 feet rise, and fall, would render it hazardous for a heavy ship to attempt to enter. Then I come to the Humber. So far as ironclads are concerned, it is not a safe place. The reach runs straight up from the sea, and I do not think that you could calculate upon being able to go alongside a coal hulk in the Humber with the wind anything between north-east and south-east. The bubble of the sea would be so great, that you could not lay alongside to coal. With respect to the Tyne, no ironclad would attempt to go in there. The narrowness of the entrance and the strength of the tide render it a port not fit for heavy draught or long ships, and from my own personal observation I can tell you that there is nothing between the Thames and the Frith of Forth in which a large ironclad could calculate on coaling with certainty. I therefore cordially agree that the time has come when it is necessary that a harbour should be made on the east coast. In these days of steam we know that vessels must be supplied with fuel. If they are not, their efficiency is gone; yet there is no place where they can get coals with certainty, from Sheerness to the Frith of Forth. There is one observation I would make with respect to the closed harbours. The Downs, and Yarmouth Roads, and Hollesley Bay have been spoken of as places where ships can take refuge from a superior fleet; but if a superior fleet drives an inferior one into such a place, the batteries on shore cannot protect the latter with the same efficiency as if they were in an artificial harbour, where the guns would be outside the ships. I have now, gentlemen, to ask you to join with me in thanking Sir J. Coode for his paper which he has given us. There is no occasion for me to say one word more, for I am sure we must all feel the great debt which we owe to him. The mass of statistical information contained in it, as well as its general character, will render it a most valuable paper for us to refer to in future.

TABLE,
Shewing areas of Sheltered Anchorage, total Cost of Works, and Cost per Acre of Deep-Water-Portions of National Harbours (arranged in order of Cost per Acre of Deep-Water-Anchorage).

N.B.—The areas and cost of the several harbours referred to in the body of the Paper are here given at one view, the relative cost per acre being exhibited by the two right hand columns of figures. These figures are adduced for the purpose of showing the comparative natural advantages of the respective sites, and the importance of selecting for any harbour of this class, the most suitable site within any given district.

Name of Harbour.	Areas of Sheltered Anchorage.			Total cost of works.	Cost per Acre taken over deep water portions.		Name of Harbour.
	3 Fathoms and upwards.	4 Fathoms and upwards.	5 Fathoms and upwards.		4 Fathoms and upwards.	5 Fathoms and upwards.	
	Acres.	Acres.	Acres.	£	£	£	
Kingstown	130	34	Nil.	814,000	23,941	no 5 fathoms	Kingstown.
Alderney	150	114	80	1,274,000	11,175	15,925	Alderney.
Dover	170	145	122	*1,550,000	10,690	12,705	Dover.
Holyhead	300	260	200	1,285,000	4,942	6,425	Holyhead.
Cherbourg	1,650	1,350	890	2,675,000	1,981	3,006	Cherbourg.
Plymouth	1,380	1,260	800	1,517,000	1,204	1,897	Plymouth.
Portland	1,590	1,430	1,290	1,033,000	722	800	Portland.

* Western Arm (now in progress) £800,000
 Eastern Arm (proposed) estimated at 750,000

Ebening Meeting.

Monday, March 15, 1875.

MAJOR-GENERAL SCHOMBERG, C.B., R.M.A., Deputy Adjutant-General, in the Chair.

NAMES of MEMBERS who joined the Institution between the 2nd and 15th of March, 1875.

LIFE.

Wilson, John G., Lt.-Col. 1st N. York Rifle Vols.
Buxton, J. W. F., Lieut. 27th Regiment.
Biddulph, M. W., Lieutenant 5th Fusiliers.
Dickinson, Edward, Lieut. Royal Engineers.

ANNUAL.

Lascelles, W. R., Capt. Rifle Brigade.	Wilson, G. H., Lieut. 26th Regiment.
Eden, Morton P., Major R.A.	Tower, Arthur, Lieut. 95th Regiment.
Taylor, Alexander, C.B., M.-Gen. R.E.	Blomfield, R. M., Captain R.N.
Hickman, D. H., Lt.-Col. Ben. Staff Corps.	Lawrence, W. A., Capt. Ben. Staff Crps.

ON HARBOUR-DEFENCE.

By MAJOR MONCRIEFF, F.R.S., &c., &c.

SINCE 1866 I have had the honour of reading five papers in this theatre, relating more or less to the question of coast defence—a question, it must be allowed, of some importance in a country like ours, whose frontier is the sea: a country, moreover, which has the largest mercantile marine in the world, and which is becoming every year more dependent on distant colonies and other countries for its resources.

On the last occasion (9th June, 1873), my remarks were mostly confined to the disposition of very heavy artillery, and to answering a paper on my system by an Engineer Officer of the Works Department, who advocated in this theatre the rival system of iron shields and concentration of guns. On the previous occasion on which I lectured here (8th May, 1873), I referred more to that part of the subject bearing on the dispositions of force which would be required to repel invasion, which would only be attempted against this country on a very large scale, with great resources in reserve, and at parts of the coast least provided with the means of defence.

At present the few remarks I shall venture to advance will be confined more to the necessities of commercial and other harbours—the gates through which the commerce of the world passes into our home, and colonial empire, and which are occasionally depôts for our steam Navy. The subject to be discussed in this paper, therefore, is one not only connected with the question of invasion and the strategic conditions involved in that problem, but it has a more immediate connection with the common requirements of an empire depending on the ocean for communication with its colonies, and uninterrupted commerce with friendly countries in all parts of the world.

£800,000
750,000
Western Arm (now in progress)
Eastern Arm (proposed) estimated at

The defence of the country against invasion is generally treated (perhaps unwisely so) as a contingency too remote to require much attention. The protection of our harbours, however, is a question which at any moment might become of pressing necessity, although no invasion were contemplated at the time. It is, therefore, a question to which it cannot be out of place to draw attention, so long as it is true that inadequate provision is made for harbour defence.

Last year, under the title of "The Strategic Importance of the Military Harbours in the British Channel," Major-General Collinson, R.E., read in this theatre one of the ablest papers I have had the privilege of hearing on this subject. I quite concur, I may venture to say, as all who have given much attention to the subject do, in the views then advanced by General Collinson. The field, however, is a large one, and there is room for many workers. I trust that my few observations may in some degree supplement what he, Sir John Coode, Captain Colomb, and others have so ably advanced in this theatre on the same subject, as well as what I have myself already contributed to it.

The general naval arrangements for the protection of our extended commerce in every sea—than which a greater naval problem probably does not, and never did exist,—touches this question of harbour defence very nearly, and more so than formerly, because the fleets of England can no longer be independent of them; and steam war ships must have their harbours and coaling stations placed in proper positions in relation to the cruising ground which the Navy has to hold. In maintaining an efficient Navy, therefore, and to obtain the greatest results with a given expenditure, the question must be kept in view how much of that expenditure is to be devoted to the ships themselves, and how much to the harbours, coaling stations, &c., which are absolutely necessary for the ships in time of war.

The feeling of the country generally concedes the paramount necessity for our maintaining a supremacy at sea to protect our commerce, and to counterbalance the military supremacy of other first-class powers. As a rule, however, this concession does not embrace any question beyond the ships. It is not sufficiently known that a modern war navy without proper harbours is somewhat analogous to a modern army without a commissariat and transport. The question is, consequently, a very serious and pressing one, however much it may be overlooked.

Harbours are a most important element in the naval defence of the Empire, and their *proper* and *economical* protection is a question of great and immediate importance. General Collinson says, "A coaling station should be fortified against an attack by sea, otherwise you will be providing a dépôt for your enemy;" and "It must be remembered that every harbour left undefended is not only a loss to your own vessels but a gain to the enemy."

A share of the resources which are devoted to the defence of the country is demanded both for military and commercial harbours. In what manner this expenditure can best be made is the question before us. To answer this in a short paper is impossible, and one instance is no sufficient illustration, as the conditions surrounding harbours contrast

¹ See Journal, vol. xviii, page 227, *et seq.*

with one another in the most remarkable manner. If I can succeed in indicating the character of the general principles involved, as they appear to myself after some study of the matter, and of the nature of the alternatives at our disposal for harbour defence, it is as much as can be done. It will be expected from me that I shall give the greater prominence to the system which bears my name, and with which I am most familiar. I must take for granted, however, in referring to that system, that its character is understood from my former descriptions, that when the system is spoken of, there is much more implied than merely the gun-carriages which are used to carry it out, and also that it is known that the Moncrieff batteries which have been laid down and constructed at home and in the colonies do not adequately represent that system, but, on the contrary, generally embody many of the defects inherent in works employing iron shields, the other alternative generally adopted for heavy coast artillery.

The protection afforded by sea-going war-ships to the harbours on their own cruising ground, and by the harbours to the ships, is reciprocal. Besides this kind of protection, harbour-defence would consist of four other elements, all of which would likely be more or less represented in each important case.

To obtain the greatest results, however, at the smallest expenditure, each of these elements requires to be increased or reduced according to the character of the harbour, the nature of the approaches to it, and the kind of attack to which it would most likely be subjected.

The four elements referred to are :—

1. Coast vessels of small draught.
2. Obstructions, torpedoes, &c., supported by artillery and coast vessels.
3. Heavy coast artillery.
4. Arrangements for signalling, firing torpedoes, judging distance in the batteries, and enabling all the elements of defence to act in concert with one another.

With reference to the first of these requirements, I believe it is the general impression at present that the most effective vessel for the purpose is a small gunboat carrying a heavy piece of artillery. The positions in which such vessels would be most effective, would generally be where sandbanks and large areas of comparatively shallow water would enable them at considerable range to converge their fire on the larger and deeper sea-going vessels which ventured the attack. Their tactics would be a part of the same plan which included the disposition of obstacles, the laying and firing of torpedoes, and the covering fire of the land batteries employed.

With regard to these vessels, a most valuable suggestion was thrown out in this theatre by the late Chief Constructor of the Navy, Mr. Reed, to the following effect :—

“I would build two or three vessels essentially for training, and I would provide those parts, such as the forgings of the ship and engine, which you cannot produce quickly, for the remaining 28 vessels. Then, if the probability of war approaches, I will venture to say in a fortnight, or at the most in three or four weeks, you

"might turn out the 30 vessels, and you would have already passed through the two or three finished boats the number of trained men requisite to man the whole."

The application of torpedoes has become a science of itself. It appears to me, however, that their application will always be most effective when carried out strictly as a component part of the naval and artillery tactics of each position.

The greatest difficulty in working torpedoes to advantage when the channel is extended, is the establishment of stations from which to work them; and when these stations must be floating ones that difficulty is increased. As a rule, however, harbour defence will be most efficient when the four elements above stated can be brought to act simultaneously and in support of each other.

Putting aside self-acting torpedoes, which are alike dangerous to friend and foe, and which for that reason are avoided, except for special cases, the torpedoes fired by electric means require at least one station for this purpose. It is of some moment that these stations should not only be protected but also concealed, and that any approach to them should be made dangerous to boat parties. Accurate shell guns and howitzers in masked batteries, and in some cases Gatlings, would be the weapons most suitable for such positions and it would in many cases be desirable that the stations should be protected both from land and sea by the same means. In any case it would probably be objectionable to construct such stations so that they could be attacked and destroyed by long range and heavy artillery fire from war vessels, while the necessities imposed by the natural configuration of many harbours would expose them to such attack. In such cases it would obviously be of the greatest importance to utilize to the utmost the power of masking the batteries, which a proper application of the Moncrieff system affords.

For similar reasons the shallows and creeks, if any, on the flanks or in the rear of such stations would often be advantageous for the low and light-draught gunboats above referred to.

It would always of course be desirable to keep the system of defence sufficiently in advance of the docks, and other important property, to prevent their being fired by the enemy's long-range guns.

With regard to the disposition of heavy artillery for purposes of coast defence, and more especially for harbour defence, there is a divergence of opinion, to which I believe it is of the greatest importance that both professional and public opinion should be directed, and I would appeal to both: to the former, more on the ground of efficiency; to the latter, on that of economy.

It is not unknown to the members of this Institution that many millions of money have already been expended on coast fortifications, and that the expenditure on coast works is still proceeding.

The Right Hon. the Secretary of State for War on the 8th instant, stated to the House of Commons that "during 1874-75 £200,000 will have been expended on fortifications that are being built under a loan, and I think I may say it has been mainly spent on iron shields for the forts."

This great expenditure has been almost entirely absorbed by works largely dependent on iron, and on the principle of concentrating the guns, still adhered to, which was advocated by an Officer of the Works Department in this theatre on the 31st March, 1873, and which, in fact, characterises nearly all our works, notwithstanding the serious defect of limiting their lateral range, thereby reducing their value. This principle is very much the old system of coast batteries employed before the introduction of modern artillery, but reinforced by the use of iron shields. In some cases, on the plea of economy or of space, the guns have not only been concentrated laterally, but, as for example, at Garrison Point Fort, and elsewhere, have been mounted in tiers one above another. I submit that it is rarely expedient to concentrate many guns in a small space, and that in the large majority of cases the greater the interval between very heavy guns and the more difficult it is to see their position, the more formidable and embarrassing do they become to the enemy.

The divergence of opinion to which I refer exists between those on the one hand who still advocate this expensive and concentrated system, and those, on the other hand, who, accepting more or less my ideas, advocate the dispersion of the means of defence in preference to its concentration.

I venture to affirm that the great majority of the Officers of both special arms, and of the Royal Navy, approve of the latter alternative. The carrying out of this alternative requires that the works themselves should be simple, as much as possible concealed from sight, capable of being adapted for all future changes in artillery (which casemates are not, without reconstruction), and even allowing of improvised expansion by unskilled labour; while the flank defence could thus be obtained independently of the position of the guns, and increased at need to any extent. For all these purposes the barbette system, especially a protected barbette system, offers singular facilities. In fact, the system consists of the disposition of the guns "in such a manner as to retain as much as possible for the defence the advantages of a free lateral range, converging fire, and different amounts of command. In other words, the method consists in placing in position the heaviest and most powerful artillery to the greatest advantage, making that the first consideration, and afterwards protecting the batteries, by separate and distinct arrangements easily devised by Officers on the spot, against assault by any force that ships might land for that purpose." The system was considered by the Select Committee appointed to report on it under the following heads:—

- "1. That as powerful coast-artillery need no longer be confined for the sake of protection to ports and embrasures, the new works should be designed expressly to obtain the full advantage of unlimited power of traversing, except in special cases.
- "2. That as there is now the possibility of concealing from an enemy the exact position of the guns, they should no longer be placed as if they were protected by shields and casemates (which by their nature must be visible); but that on the contrary every peculiarity of the ground should be employed to render the exact position

"of the guns more difficult to determine by a floating enemy: for this reason, that whatever tends to make batteries difficult to see and to hit, is as much a protection as that which makes them capable of resisting a hit when made.

"3. That as a different and more scattered disposition of the guns is required to obtain the two former advantages, this peculiarity (which has its disadvantages) should be seized and utilised for other requirements, and that the arrangements should be considered with a view to extemporizing more complete protection from assault in time of war.

"4. That as there will occasionally be detached pits supported by, or in support of, such works, the pits themselves should, in such cases, be made defensible by musketry, and the details of these pits and their carriages should be considered together in relation to this requirement.

"5. That the arrangements for range-finding, and conjoint action between batteries in the same work, should be a primary consideration in its design."

I trust you will bear with me if I urge the advisability of considering the system which bears my name, in providing for future harbour defence, so as to obtain for it a share of the attention that is freely bestowed on iron shields and casemates, which, in all but exceptional cases, are the only other alternative giving sufficient protection to the guns and to the men serving them from the attack of heavy naval artillery.

Wishing to confine my remarks as much as possible to commercial harbours, I submit the following reasons why this system is worthy of more attention for that purpose than it has yet received.

In the first place, I would echo the sentiment so eloquently advanced on the 26th February in this theatre by General Collinson in his lecture, entitled "A Warning Voice from the Spanish Armada," viz., that the defence of England was best secured when entrusted to the local action of her own brave people, who should be encouraged to feel that this duty rested on every able man in time of need.

This maxim is particularly applicable to harbour defence.

Commercial harbours are always the seat of considerable populations, and are not unfrequently in populous districts. Their defence should therefore be conceived on a plan which in war time could be expanded, improved, and worked to a large extent by local resources. It is in this way that real efficiency and economy are to be combined.

I would ask whether this desirable result is to be obtained more completely on the system of shield and casemate batteries, the system on which the expensive iron-cased works which have already absorbed five millions of money are constructed, or on the other system, which can be applied at a smaller expense gun for gun, while each gun can be placed so as to do the work of two or more guns behind iron shields, and the flank defence of which can be increased with unskilled labour to any extent that the ground will admit.

The iron-shield-system to be of any avail, involves an immediate

expenditure on complete iron-cased batteries requiring a long time for construction, and which cannot be altered for changed conditions or immediate requirements.

I make the following quotation from an answer by Captain Innes, R.E., in the *Royal Engineer Journal* to Lieutenant English's criticisms on the Moncrieff system:—

"It does not seem probable that works of the type now proposed, and with well considered details, would have much to fear from the long range bombardment which the original paper prescribes as the appropriate mode of attack for shipping to employ against open batteries; it is indeed only suitable against either a very large or a very distinct mark, such as a dockyard on the one hand, or a large number of guns crowded into a small battery on the other. The open batteries of the original paper are undoubtedly very favourable subjects for such treatment, and even the casemated works would, I think, suffer from it quite as much or more than those now advocated; they present a very good mark, and their perfect invulnerability is at least questionable. I do not think there is any example on record of shipping doing serious injury at a long range, except to large vulnerable areas or small crowded works.

"Of the two methods, I think the one now proposed may fairly claim greater elasticity and capacity for expansion; one cannot add materially to the structure or armament of the casemated works without a more or less complete reconstruction, during which they will be in a great measure dismantled and unfit for action; but in the long roomy batteries it will be possible to interpolate better or heavier guns without disturbing the old ones till the new are ready, when some of the lightest may, if necessary, be weeded out, or transferred to extensions on the flanks; they may also be materially strengthened by the addition of even comparatively light guns in this last position, which will at least distract the enemy's fire from the more important pieces in a way that could not be done by a similar supplement to the casemated works, which will always stand out clear and unmistakable from any temporary addition. I was informed, when at Charlestown during the siege, that only the heaviest guns, which were but a minority of the armament of the defences, could really do much harm to the armoured vessels of the attack, but that the lighter pieces with which they were associated, and which were easily handled and replaced in case of accident, were found extremely valuable in drawing off a portion of the hostile fire."

I would here most strongly urge as an objection to the concentration of modern artillery which consumes so much powder, that the volume of smoke emitted would, in some states of the weather, make a large battery more useless than one gun free from this encumbrance.

The fourth and last element, which I instanced as essential in harbour defence, viz., that relating to general arrangements, is one, in my humble opinion, the most important of any; without it the others could not be worked in concert. Powerful artillery is not more effective than light pieces, unless the exact range is known. Each method of defence is by such means reinforced by the other; indeed, the defence

of an important position, without a carefully devised plan of co-operation, is somewhat analogous to an army without a staff. A great waste of power, and the risk of dangerous mistakes in action, would be inevitable without this provision.

It is an element of defence which would be far more troublesome, requiring much more special local study to arrange, but not nearly so expensive as the construction of a showy battery. It would not gratify the eye so much as a majestic fort with ponderous guns all brought together for inspection; but on the other hand, it would be extremely dangerous to the enterprising enemy who ventured within its action, and it would be a means of defence that, in my humble opinion, should be always kept prominently in view in laying down and arranging the defences of a harbour.

The general system now advocated for harbour defence, and composed of the four elements referred to, is one in which the full advantage of converging fire is seized; in which the batteries are connected by screened roads and railways, and covered by trenches for infantry and light artillery; which has a proper arrangement for range-finding and working the torpedoes, and for concentrating the fire simultaneously when obstacles stop the channel; in which the artillery is dispersed and as much as possible masked; which is capable of rapid development on the threat of war; and which is cheap and lastingly efficient.

It appears to me that the great object to be attained in protecting our commercial harbours, is to get, at a reasonable expenditure on *matériel*, the greatest amount of protection along with an organization, and a training of the militia and local volunteers in the use of the weapon with which they will be entrusted on the outbreak of war; this would make a harbour truly formidable to an enemy, and probably deter him from risking an attack.

The majority of those present are probably aware that two important Committees, appointed by the Secretary of State for War expressly to consider the comparative merits of the alternatives now at the disposal of the country for protecting our harbours, and for other purposes, have had this general question before them, and that they both arrived at practically the same conclusion on the subject. That conclusion was extremely favourable to the alternative I am now advocating so far as it was considered by these Committees.

I cannot do better than quote the words of the last official report on the general question.

"In comparing the relative efficiency of guns mounted on Moncrieff carriages with guns mounted in the ordinary way, the Committee have to remark that the experience gained with the carriage for the 9-inch gun of 12 tons, since the date of their report of 9th December, 1871, fully confirms the opinions they then expressed as to the superiority of the former in regard to the following points, viz. :—

"1. Facility of loading.

"2. Facility of laying, and that the gun can be laid with sufficient accuracy without the exposure of No. 1.

"3. Rapidity, as compared with that of a similar gun on a dwarf or casemate traversing platform.

"4. The time the gun, when fully engaged, may be regarded as exposed compared with the time it is fully covered.

"5. The degree of protection afforded to the men, shell-rooms and expense magazines, as compared with that afforded by iron shields.

"As regards economy and efficiency, therefore, the Committee consider the Moncrieff system compares very favourably with that of the Service, especially when it is considered that from its extensive lateral range one gun mounted on a Moncrieff carriage may do equal work with *two or more guns* mounted behind shields.

"The question as to how far it can be adopted at the present time, when most of the great defensive works of this country have been completed, or nearly so, can of course only be determined by the proper authorities. The Committee may, however, remark that in their opinion the system will be found particularly well adapted for—

"1. Mounting guns in salients, &c., of land defences, and

"2. Mounting guns for subsidiary defence of existing heavy sea batteries; they allude more particularly to such works as Picklecombe, Bovisand, &c., the guns of which being essentially armour-piercers, should have associated with them guns of lighter calibre for shell fire.

"3. *The defence of the great commercial harbours.*

"The expense of mounting a few 12-ton or possibly heavier guns on Moncrieff carriages would be considerably less than placing them behind shields or in casemates; while the increased protection afforded to the men over that of guns *en barbette* would be a matter of great importance.

"With regard to the employment of the Moncrieff system for mounting guns of large calibre on sea-defences, the Committee, as already pointed out, are of opinion that it might be resorted to with advantage, but the extent of its application necessarily depends upon local and other considerations, of which the Committee can have no cognisance.

"Should it, however, be contemplated to project new works for the defence of important positions, or to supplement existing works by others of the present type, the Committee are strongly of opinion that the designs should be re-considered with a view to the employment of the Moncrieff carriage; and they would suggest that with the object of securing harmony between the designs, both of works and carriages, Major Moncrieff should be afforded an opportunity of expressing his opinion officially upon the plans that may be proposed."

I venture to say that nothing could be more decidedly in favour of the alternative advocated by me than this report, which was made by a Committee which had for years investigated the subject.

I cannot, however, permit myself to doubt that in a matter of such great national importance, as an alternative system for coast defence,

which is both efficient and economical, the Secretary of State for War, who is taking so deep an interest in the great Department over which he presides, will eventually arrive at a decision as to what is the best course to pursue, and the best system to apply in each case.

The Officers who have recently addressed you on this subject, indicated where harbours are required, and when they should be armed. I have endeavoured in this paper—I fear very imperfectly—to suggest how they should be protected if the considerations of economy and efficiency are to have their due influence in the selection of the system which is to be adopted. I have tried to suggest the various points on which a discussion might be raised on the two broad principles of *concentration* and of *dispersion* of coast artillery, with the latter of which my system has always been identified, and I have curtailed my paper to give more time for an expression of opinion on this important subject.

I trust that any gentlemen who advocate the concentration which characterises our present coast batteries, will be kind enough to give me an opportunity of meeting any objections they may entertain to the method of dispersion which characterises my system.

Admiral Sir H. CODRINGTON, K.C.B. : I have listened to Major Moncrieff's paper with great interest indeed, because I feel that, in almost everything—I think I may say, in everything that he has said, I can coincide with him entirely, from what I have seen and experienced. I should think there really cannot be any doubt, at the present day, as to the difference between guns mounted on his plan and those that are mounted on shields, and I have never had any doubt whatever on the subject since I have seen the two systems. The batteries defending Plymouth Sound are first-class batteries, beautifully constructed, armed with the finest guns of the day, defended by the most solid and beautiful shields that could possibly be made, and, I may say, manned by the finest fellows you could see in any country; but it was rather an instructive thing to see that, when those three things were put together—the constructor's work, the engineer's, and the artillery—the system did not work. I was present when the fort at Bovisand was tried, and I thought that it was very instructive. Of course, the object was to fire at a ship supposed to be coming in. The guns had been put in, and were actually mounted, and one was worked and fired, in order to show the efficiency of the battery. When it was run out, it certainly did not project beyond the outer face of the work itself. The consequence was that they had to take the buffers off in order to allow the gun to go out, and, even then, it was just square with, what a sailor would call, the outside face of the port, and no more. You will excuse me, if I use a sailor's term with regard to this matter. Even when fired square in the port, the concussion was very great, and a good deal of smoke and fire came in; but that was nothing compared to what the effect was when, supposing a ship had passed the direct right angle, and they had to fire to the extreme right or left, as the case might be, the gun was fired when trained to the right, for the muzzle of the gun was then within the outer face of the work. I do not think that gun would have worked at all; in short, I am sure it would not. The quantity, not only of smoke, but of fire, that came in then, and the concussion, were so great that nobody could well have stood at that gun. Nobody did stand at it, for everybody retired to a safety-position in the next casemate. We jumped in as soon as we could afterwards, and we found the rope mats or mantelets a hanging mass of fire, although they had been plentifully baptized with salt water. Each time that was the case. The gun thus fired was fired twice, but the experiment was quite sufficient. Everybody was quite convinced that that battery would not do so; and the authorities dispersed. Some time afterwards, I wanted to see what was done, and I went over the battery. They were making some alteration, and, as it was not expedient to alter the racers, they had altered

the inner trucks on the carriage, so as to get it further out. The consequence of that was, that the bolts in the slide, when they came to try and train that gun again, would take the ironwork of the embrasure, and they would have to cut them off; but, even then, the ironwork of the slide itself would have taken the side of the embrasure, so that that gun could not properly be fired with requisite training, even when the alterations had been made. I do not know what they have done with that battery since. I am speaking of three or four years ago. It showed, however, that after all the best intellect, in that department had been employed upon the work, there was not the lateral range on each side that is required to deal with a ship coming in. Those batteries were beautiful batteries. There are several there. I merely name the one that I saw these exercises take place in, but the same thing holds good of each of those batteries. So far as they are casemated and point down a channel, where there is not much pointing right or left required, they are excellent in their way for defence. I am speaking however as a sailor, with regard to the general principle, and supposing that I, as an enemy, wished to go into one of those harbours, I would thank any man to be kind enough to put all the defences of the harbour in one place, because I should then know how to dispose my force so as to deal with them. But if they put their guns detached, one or two at the utmost near each other, in different places all round, there is no possibility of facing them. I do not believe that a ship could live against guns detached in different positions all round, but she may have a chance against a battery that she may bring her broadside to bear upon, particularly if she can find an anchorage near one of those beautiful forts, a little beyond the line at which they can train. It is an evil, inherent in guns in such a position, that they cannot train from the excessive thickness of the parapet inside of the shields more than a certain small number of degrees, and, in most cases, a ship will find a place where she will be able to bring her guns to bear upon the fort, and do it a great deal of damage, provided there is nothing else that can hit her at the same time. I am not saying that those forts at Plymouth Sound are not well placed, but I mean to say that detached guns are far more dangerous to vessels than when they are concentrated. There is another thing which I should like to allude to. In the defence of such places as Plymouth and Portsmouth, it is sometimes very difficult to get the quantity of ground that is required for detached guns. The landowner will be content to give up a small corner of his garden, but not a number of places in which an engineer would like to put detached guns. The consequence is, that the Government have to spend a large sum of money to get detached guns placed in position. There are more places to buy from the landowner, and the experience of Government has shown that landowners charge very highly for these things. The same may be said with regard to the connecting roads. If anybody would enquire the price of a road communicating between Polhau battery, at the back of the Rame Head, and the other fort, Tregantle, they would find that a very large sum was required for remuneration there. It is right to take all this into consideration when we advocate, as I certainly do, detached guns instead of concentrated guns.

Lieutenant BOWER, R.N. : I do not presume to criticize Major Moncrieff's lecture, as I am not sufficiently acquainted with the subject to do so, but there is one thing that came under my observation, which illustrates it very fairly. I remember some years ago, at Malta, the "Magicienne" was sent outside the harbour, with instructions to steam in; the forts were ordered to see how many shot they could fire at her while she was coming in. She kept at a speed of eight knots. Previously, Malta had presented to me the appearance of one of the most impregnable fortresses in the world, especially when looked at from the sea, but I was perfectly astonished at the small number of guns that they managed to let off at her. I do not remember the exact figures, but I remember that the "Magicienne," a sixteen gun frigate, managed to fire more rounds than the whole of the forts and batteries of Malta. I would, also, wish to say a few words on the general subject of coast defences. It seems to me, there are two ways of defending our coast, and that we have to consider, not only their advantages, but that which the country is willing to pay for. The two ways I allude to are, first, the defences of the coast itself on our *own* coast, and next, the defence of our coast on our *own enemy's*. I certainly think that the second alternative has many advantages over the first. The first requires large

harbour defences and heavy forts, which, even at the best, cannot be perfectly impregnable. The second requires a large and overwhelming sea force; but the advantages gained by it do not admit of comparison with those gained by the former method. England is a country entirely dependent on her commerce for the sinews of war, and if we maintain a sufficiently large Navy, not only to lock the enemy up in his ports, but to keep him there, we place ourselves in a position to provide the sinews of war and to carry on the war, and at the same time impoverish our enemy. Whilst I am on the subject of harbour defences, there is one point which I should wish to draw attention to. It has already been touched upon by Major Moncrieff. I mean the localization of that defence. During war-time our fleet would have ample duties to perform, and very few men to spare for harbour defence. Foreign nations are now building small torpedo vessels, and we must assume that their advance on our harbours, if made at all, would be made at night. This, on a declaration of war, would necessitate the presence at every one of our large arsenals of a large flotilla of boats during the night. They would have to be kept out, and this watch must last during the whole continuance of the war. The Navy is unable to provide the men for such a case, but there are watermen and fishermen in all our ports who are thoroughly acquainted with the harbours to which they are attached, and it is only necessary properly to organise them in order to keep up the necessary picket and sentry duty off the mouth of the harbour. They would not be required to fight, but their duties would be confined to giving warning of the approach of ships, so that the forts might be ready to receive the enemy. I would strongly urge the necessity of some such organisation at Portsmouth, Plymouth, and all our large ports.

Captain NESBIT, R.A.: I should like to ask Major Moncrieff a question with regard to a statement at the end of his lecture. He mentions that the second Committee in their report recommended very strongly, that the plans of batteries in which his system is adopted, more or less, should be submitted to him, or at least that he should co-operate to a certain extent with the engineers and those charged with the construction of the batteries. I should like to ask him whether, in any of these matters, he has been consulted by the Royal Engineer Department, because it appears to me to be one of the most important points with regard to the adoption of his system, that the inventor, who is aware of its capabilities, should have a voice in directing, or at least pointing out such modifications as would be necessary for the construction of batteries under his system. His theory of a diffusion of artillery instead of concentration, has already been largely adopted in this country. At the end of the great continental war in 1815, Martello towers were constructed all over the country for the defence of the coast. There was a frigate powerfully armed kept off by one or two guns on the coast of Sicily. Of course, these towers, being constructed of masonry, are not adapted to the exigencies of modern artillery, but they were examples of the diffusion of artillery as opposed to concentrating guns at one point. Of course there is no comparison between the Martello towers and Major Moncrieff's battery, further than the mere fact that both were opposed to the concentration of the defence. Of course the Martello tower is an obsolete matter in fortification now; but the Moncrieff battery, which is more or less invisible at ordinary ranges, adopts the same principle without the inconveniences of the old Martello tower.

Colonel STRANGE, F.R.S.: I think the question that has been put to Major Moncrieff a very pertinent one, and bears on a passage in the paper which, in order that I may be exact, I will read as follows:—"I must take for granted, however, in referring to that system, that its character is understood from my former descriptions, that when the system is spoken of there is much more implied than merely the gun carriages which are used to carry it out, and also that it is known that the Moncrieff batteries which have been laid down and constructed at home and in the colonies do not adequately represent that system, but, on the contrary, generally embody many of the defects inherent in works employing iron shields, which are the other alternative generally adopted for heavy coast artillery." I understand from that, that the system known by the name of the inventor has not been carried out in its integrity in certain cases, and that would certainly imply that Major Moncrieff has not been as fully consulted as the Committee, whose report he

quoted, recommended he should be. I think, therefore, the question that has been asked by the gentleman behind me is a very appropriate one, and I hope Major Moncrieff will throw some light upon that subject.

Captain R. A. E. SCOTT, R.N.: I am sorry that Sir J. Coode's paper¹ only came into my hands this evening. It is impossible to master such a very important paper at such short notice, so as to speak of its more salient points as I should wish; but at the same time there are one or two remarks which occur to me. We have just heard that our large seafaring population is close to where an enemy would try to effect a landing, and thus our shores are provided with the chief means of defence. Sir J. Coode has advocated Filey Bay as the best central position for a harbour of refuge. There can be no doubt of the value of such a harbour for our mercantile marine, and it would also be of the first importance in any naval war to have so good a base of operations in the North Sea. Without such a position as Filey Bay I really do not see where on the east coast a base of operations could be established. We want on that shore a place where our ironclads could assemble, and where our gunboats also could find shelter. I look upon gunboats as a most important arm, but not such small gun-boats as we have at present, mounting only an 18-ton gun. The gunboats we should have upon our coasts ought to mount guns quite as heavy as anything that could be brought against them, so as to be enabled to attack the most powerful ironclad, with a certainty of penetrating her. At the same time these gunboats should have great speed, for without high speed they would be of little use; for gunboats ought in fact to be like a nest of hornets, following up any enemy that may put in an appearance, and acting as our vessels did with regard to the Spanish Armada; that is to say, if not directly attacking an ironclad squadron, or any off stragglers from it, and entirely precluding a landing. But without a harbour on the east coast what are we to do in time of war? Our ironclads and cruisers carry from six to ten, and some of them even fifteen days' coal; and some might perhaps carry sufficient fuel for twenty days' steaming, because it is not always necessary to go fast; but directly an ironclad or cruiser is out of coal she is in reality no longer formidable as a war vessel. As regards sails, most men in command of ironclads would like to get rid of them altogether when they went into action. Shells might set the sails on fire, and they and their masts might come down upon deck, and very materially interfere with fighting the guns. A still greater danger is that their cordage might foul the screws. In fact, for our heavy war vessels sails are rather an incumbrance than an advantage. Our fast unarmoured vessels have sails that can move them, but if you were to add to the sides of those vessels a couple of thousand tons of armour, you would get such a weighty mass that sails could have very little effect upon it. Ordinarily without steam, and in a swell, ironclads lie like logs (except as to excessive rolling); in fact, with the bigger ironclads it is found not to be safe to keep in close order unless the steam is up, or at least the fires so well banked up that steam could be got up very quickly. It is therefore doubly important to provide harbours of refuge on our own coasts, which would be of course coaling stations. Without these I do not see how England is efficiently to carry on a great war, and keep her fleets and cruisers supplied with coals and other munitions. I might go further and say, that wherever we have vessels in any part of the world we should have coaling stations, so that our cruisers may be kept at all times ready for action, and equal in efficiency to any vessels they may chance to meet. We have to maintain our power in all seas, and we cannot do that without coaling stations. If such stations are so necessary at a distance, how much more necessary are they to furnish a secure base for operations from our own coast, and I therefore think we ought all to feel very much obliged to Sir J. Coode for bringing forward this important subject so ably in his paper. With regard to what Major Moncrieff has said about concentration I think there can be no doubt but that concentration of heavy ordnance is a mistake. It is even a mistake on board ship. The present slow-burning powders give off much more smoke than those used formerly, and this smoke hangs about the ports; heavy firing, also,

¹ The discussion was intended to be taken on General Collinson's lecture, and on Sir John Coode's and Major Moncrieff's papers.

has a tendency to cause a calm, and hence, in the case of concentrated guns, we should not be able to see the enemy after a time. Looking at this question from every point, I think there can be no doubt but that the dispersion of heavy guns is a much more valuable arrangement than concentration. Concentration was good when we had light guns, but the whole circumstances of war are changed. Now, we have several shot rolled into one. What we fairly want is more powerful guns, more powerful shells; and then we may easily expect that success, which we have heretofore had, and which I believe will ever attach to our fleet.

Admiral OMMANNEY, C.B., F.R.S.: One of the speakers very justly observed that there appears to be room for all the different systems which have been proposed, and there is one thing which I think ought not to be lost sight of, namely, the turret of Captain Coles. I think in coast defences that might be very useful, especially at salient points, such as the extremities of piers and breakwaters. For instance, at some of the salient parts of Gibraltar, I think the turret might be still available, and in narrow channels, such as the Needles passage, turrets on Captain Coles's principle might be applied with advantage, instead of stone fortifications.

Captain OWEN, R.A.: I am sure we must all agree that whether we regard Major Moncrieff's system as the best or not, we owe him our thanks, as soldiers and sailors, for so ably bringing forward the subject of coast defences. At the same time it is almost a pity that such a question should be suffered to degenerate into a mere comparison between one system of protecting guns and another. Surely there is room for both systems. Why then should they be regarded as alternative systems? Cannot they both be used simultaneously? I think they can, and with great advantage. Major Moncrieff has laid before us very clearly the several elements that we require for defending a harbour. We all, I am sure, agree with him regarding the four elements which are necessary, and also that the fourth is, as he said, the most important of all. Now, what is that? It is the being able to work all your defences in unison. Why should it not be so then with concentrated fire and with scattered fire, with the Moncrieff system, and with the iron-cased forts. We want them both—we want them all—only let them work in unison. There was another point which Major Moncrieff very fairly alluded to, and that was the utilization of our auxiliary forces. That seems to me to be a subject which ought to have much more attention paid to it than it has. To-night we have heard coast defences discussed principally from a naval point of view, but, as an artilleryman, it seems to me that one of the most important things for us to attend to with regard to these defences, and especially the defence of our great harbours is, the proper training and organization of our auxiliary artillery. We want more auxiliary artillery. We want the auxiliary forces of our maritime towns to be artillery, whereas now, unfortunately, we find them in too many cases riflemen. We want riflemen for auxiliary forces certainly, but we also want auxiliary artillery gunners. We have not trained garrison artillerymen sufficient to man one-half of the guns of our defences, and I say, therefore, that the organization of our artillery forces in those places is of very great importance to the country. I do not think Major Moncrieff's system can be held out as the best of all. It is undoubtedly good, but there are in it some weak points that I think ought to be looked to, though time will not allow of my now discussing them. We want, as he says, control. In a great harbour like Plymouth, for instance, you have several forts scattered about. You have your torpedoed and your coast defence vessels, but these ought to be worked together as part of one great system under one head. If you have your guns scattered along in great rows on both sides of a harbour you will find it extremely difficult so to work them—very much more difficult than in the powerful casemated forts which fortunately for us defend both sides of that harbour, and of which we had such a doleful account just now. After that trial, which was alluded to, I myself had the pleasure of seeing those guns fired without any terrible effects on the gunners. Three guns in both tiers were fired at the same time, and the gunners, I am glad to say, for the sake of my own profession, did not run away from their guns; they not only remained in the fort, but stood to their guns in each casemate without inconvenience.

Admiral CODRINGTON: I am speaking of Borissand. That was Picklecombe.

Captain OWEN: It is a fort, opposite Bovisand, with guns mounted in exactly a similar manner.

Captain HORTON, R.N.: I have been much struck with the facility there seemed to be on the north side of the Isle of Wight for establishing Moncrieff batteries. It is sometime since I was there, and there may now probably be Moncrieff batteries there. Perhaps Major Moncrieff will say if there are. Opposite to the part of the island of which I speak, was Hurst Castle, and I merely offer this as a good illustration of the necessity for a combination of the different methods of defence at one place. Hurst Castle, I believe, is very much in the condition of the forts described by Admiral Codrington, and would suffer under the disadvantages alluded to by Captain Scott with regard to smoke. The guns there, as I have heard them described, perhaps inaccurately, are pretty much in the condition of those which have been for hundreds of years on the shores of the Dardanelles, that is, they can fire one round at the ships passing. A ship, it is true, would receive a very heavy salvo from the whole of Hurst Castle, with its eighty or ninety guns, providing the smoke allowed the whole of the guns to be discharged at the same ship. A succession of ships passing would undoubtedly suffer very heavily from the discharge of the guns, but it is evident that the advantage would be very great of having guns scattered about on the north shore of the Isle of Wight. I think that is very obvious, and affords a good illustration of the position assumed by Major Moncrieff.

Captain SELWYN, R.N.: It is under great difficulties that any one rises in a theatre of this kind to discuss such a question as this. While, on the one hand, sailors would like to tell their brethren on shore exactly what would be most formidable to them, and how to place the greatest obstacles in the way of an enemy attacking this island; on the other hand, whatever information is given here is very rapidly utilised abroad, and we find our weapons turned against ourselves. We always must have that difficulty in the present state of diffusion of knowledge throughout all countries, but I do think that after all, that profession which will have to conduct the attack on such coast defences as may exist on the breaking out of war, have a right to a very strong opinion, and have a right to have that opinion very deeply and carefully considered. It is not true that shallow waters or narrow waters enable turret ships to act with effect unless such waters have also low shores. Wherever guns with great command are placed, no turret—or armoured ship dares go near them, for she will have shot and shell sent through her decks, and out of the bottom below water, by even light rifled guns. The value of batteries *à fleur d'eau*, even when they possess several tiers of guns, is very much reduced by the use of armour on ships, but the gun of high command is even more formidable than before at close quarters, while at long range behind earthworks it offers scarcely any mark for effective fire. Admiral Codrington has referred to the condition in which he saw a battery in which it was naturally supposed that the guns were in an efficient state, but certainly at that time the battery was not efficient. However, the defects then seen may have led to their correction in more recently constructed batteries, though I am by no means satisfied that all the defects have been corrected. I would ask whether the armour of many of the forts, already completed throughout the island, would offer five minutes' protection from the guns which are now likely to be brought against them. If a shot struck the iron plates outside the gun, would it ever be able to fire a second shot at all? There is not a single battery which would not be pierced by the modern guns; there are more which would not be seriously shaken even by the guns existing at the time they were built. I think I recollect a very strong instance of that at Gibraltar, where the attempt to fire at an extreme training led to the shifting of the whole shield after the construction of the fort, which was supposed to be casemated and armoured efficiently. No one can see the end of the progress which may be made in artillery as an 80-ton gun is now spoken of as being constructed, and Mr. Bessemer, in this theatre, spoke of throwing a 30-ton shot with the utmost confidence. I think we might as well consider whether it is not better to draw upon the whole earth for an armour on land, and upon the whole water for an armour at sea, in which case we should get as much protection as the earth or sea could afford for ever after. As regards the question of the concentration or dispersion of the guns, I am quite sure that what Admiral Codrington has said finds an echo in the mind of every seaman who has ever seen an attack by

seamen upon land batteries. Great casemated land batteries can be singled out and fired at with effect at a distance at which, while under steam, no damage can be done to the ships by the forts. That is not the case with dispersed guns, which will remain as perfectly concealed up to the moment at which they choose to open their fire, as if they did not exist at all, more especially if they are in Moncrieff pits. That is a strong reason for adopting Major Moncrieff's system. As I understand his paper, he claims no more than a fair share of attention. That meets the question of unanimity in defence, referred to by Captain Owen, which is so strongly felt, and which I hope will never cease to be felt in the two services. Major Moncrieff merely complains that his system has been taken from him, and to a certain extent applied not as he would recommend. Is this fair to the public? Are they to be told that we wish to continue an expenditure of which we see no end? We tell you distinctly that we see no end to it, for if you make bigger guns we shall not only have to make bigger ships and docks, and harbours, but to enlarge our casemates, to take those guns. I do not think there is a single casemate now built that would take the heaviest gun proposed. [A Member, "Yes."] It must have been constructed very lately then, or the height between the roofs of the casemates would not admit of elevation or depression sufficient. Have you decided at what point you are going to stop with these guns? and what is to be the shape of the casemates to receive them? This difficulty would not arise in a protected barbette battery.

It is quite true that it is difficult to purchase land at all times when the Government is in the market for it. Generally speaking, John Bull thinks, and perhaps correctly, that when the State has to pay it does not much matter what he asks; but there has been, in the case of railways, a very stringent and efficient remedy applied. I really do not see when the question of national defence arises why the same remedy should not be applied in obtaining the land necessary for fortifications or other means of defence. The most important part of the whole subject is that pre-organised junction in the defence which Major Moncrieff advocates of the trained local militia or volunteers at the great commercial seaports. I am not now speaking of the Naval Seaports, which may possibly be defended by those classes which will increasingly be found under the present system of a moderate length of service around our seaports, perfectly ready and delighted to be allowed to engage in a renewal of their old trade as gunners whenever war arises, but the great Commercial Seaports may not be able to find such men. It is no training at all to put a man on board a ship where he finds a gun which was used some years ago, and may never be used again, and certainly not in war; but if you give those men gunboats, of light draught and high speed, carrying the heaviest guns that can be made, at each port they will make it their pride to make those gunboats as efficient as possible, and will constitute the true nest of hornets of which Captain Scott has spoken. They will not only be ready to meet an enemy, but also to follow him up, so that no landing that will take a considerable time, could be attempted on our shores with any prospect of success. Reserve men may be difficult to find at the right time, and even then they would be without such training as they ought to have. But the local people, the fishermen, and if you like, the militia men and volunteers, could be trained to such service; all this might be done if you were prepared to pay as much, while they were on the service of the country, as would keep their families in the same position as they had ordinarily occupied. Everything in this world is worth in results exactly what it costs, that is, it gives you in material effect exactly what you have paid for it, and those that deceive themselves into thinking that we can get these things very cheaply, or for nothing, will find when war breaks out, that the staff on which they leant has done nothing but pierce their hand. The time may well come when a very fearful retribution will fall upon those who have advocated trying everything that is not likely to answer before the things are tried that have answered well before, or that are likely to answer again, because the latter seem to be too expensive, and the former are offered as cheap bargains.

It is no novelty to find out, when too late, that such bargains are by far the dearest way of doing nothing at all.

Major MONCRIEFF, F.R.S.: With regard to the subject referred to by Admiral

Codrington, namely, the possibility of attacking large batteries while the ships themselves are out of range of the guns by reason of their position, I believe the Engineers are generally very careful to cover most of the ground with some guns, but no doubt when a position is only protected by large batteries with iron shields there are occasionally so few guns bearing on certain points that very awkward consequences might result if the ships discovered these points, and from them operated on the flanks or rear of the works. Take an example that is very near us, the Garrison Point Fort at Sheerness. It is of a horseshoe shape. In this case there is some excuse for placing a number of guns in a small space, although I do not think it was necessary to put them in tiers one above another. I was asked by the Secretary of War in June, 1869, to make a design for a three-gun battery outside Sheerness, which would bear both on the mouth of the Medway, and on the whole channel used by vessels entering from the Nore. If the Deputy Director of Works had done me the honour to carry out that design, which was submitted in October, 1869, before Garrison Point Fort was built, and if a series of such batteries for one, two, or three guns had been distributed along the sea wall between Cheney Rock and Garrison Point, the guns mounted in the upper tiers of Garrison Point Fort would, in my humble opinion, have been thus disposed in a much more effective and cheaper manner than where they are. That fort, although it bears very strongly upon the mouth of the Medway, might be severely handled by reverse fire from vessels in the Thames further down the channel. Its gorge might be breached from this point by heavy guns, and every casemate in it thereby exposed to splinters from the rear without being able to return a shot. I do not know how many guns are mounted in Garrison Point Fort, but a great many heavy pieces are concentrated there. These guns command the mouth of the Medway, but the open sea way is here (indicating the point), and thus, cannot range so far; vessels with powerful long range guns out here (pointing) might operate upon the gorge of this work in a very awkward manner for the fort, while it would be quite unable to answer them.

Colonel CROSSMAN, R.E.: Allow me to say that works for heavy guns are being built now to range along the coast where you allude to, and the work is nearly finished.

Major MONCRIEFF: I happened to be at Sheerness not very long ago, viz., in July last, and I am speaking of what existed then. No doubt what I am pointing out has been already discovered.

Colonel CROSSMAN, R.E.: And remedied.

Major MONCRIEFF: It struck me if some of those guns, instead of being put in tiers and all together, had been originally dispersed along this front in Moncrieff batteries they not only would have been less expensive, but much more formidable to a ship attempting to pass than as they now are, cramped up together in one place, where, in certain states of the wind and weather, they will be smothered by their own smoke. The price of ground, no doubt, is sometimes a very serious difficulty, but it certainly had no application in this case. I do not think it is necessary to take this difficulty much into consideration at present. Our object here is more to discuss what is the best method of defence, and others would decide how it should influence the designs in each case. I may remark, however, in regard to the system which has been advocated by me, that if efficiency is taken into account, the saving on each gun would amount to a very large sum, and that it is not necessary the works should be completed. The great thing is, to secure the possibility of rapidly making certain arrangements when they are wanted, which, in any case, would be required in time of war, and, of course, when an enemy is at the door, people will not so much object to have their hedges pulled down. The next point that I took a note of was the remark, with which I very much concurred, that our great defence is our Navy; but, in the preface to my paper, I was careful to point out that for the efficiency of the Navy, it is necessary that a certain number of harbours should be formed and protected; if I have not made a very great miscalculation, I believe that a certain sum spent in this way, in protecting harbours at points of strategical importance, would give greater efficiency to the Navy than the same sum spent on the vessels themselves. The great object is to have a powerful fleet, and a certain portion of the expenditure for obtaining that result, ought to be devoted to the harbours, coaling stations, &c. What proportion of the whole expenditure

should be thus employed I do not pretend to decide. With regard to the question which Captain Nesbit and Colonel Strange asked, it is rather a delicate matter, and one that I would have preferred not to answer. I must, however, confess that neither the recommendations on the point referred to, made by Lord Northbrook's Committee, which formed the agreement on which I took service with the Government (without which I should have been unwilling to have taken that service), nor those of the Committee, quoted in my paper, have as yet been carried out. I think Captain Owen spoke of the difficulty of working scattered batteries, as if it were greater than that of working concentrated batteries with a large number of guns. I was quite surprised at that observation, because it stands to reason that the difficulties in working a large battery are much greater than in working detached guns. In a detached battery you have the same means of range-finding, the same signals and telegraphs; you are as much within reach of the officer who is commanding the whole attack as if you were in a large battery, but without its confusion. An officer could more deliberately perform his duties, without the din, disturbance, smoke, and possibly splinters, that would more frequently accompany action in a concentrated battery. Therefore, I cannot understand how any one can suppose that the difficulty of working in a small battery should be greater than in a large one, or that the power of keeping the whole attack in hand, when it is spread over a number of small batteries, would be less complete than when it is confined to large ones, with the same telegraphic arrangements applied to both. I should like an explanation of this opinion, for I cannot understand what may be alluded to. Firing even a single shot from a modern heavy gun in a fort will create as much smoke as would a whole volley from a battery of ten guns in former times, because modern guns fire ten times more powder. The difficulty of dealing with large volumes of smoke is very serious in action; and no doubt a knowing enemy would take very good care that the wind was in a favourable direction for him, or that the state of the weather was such as would favour him and not the batteries he attacked. On a fine day, a good flank wind would blow the smoke away directly, but an enemy would take good care that you did not get that condition. It must be remembered that he, not the battery, has the power of selection. I think, therefore, when putting down valuable and important pieces of artillery, it is very desirable to have them placed in such a manner as to mask them from the enemy, and obtain the best possible offensive results. With regard to Captain Selwyn's remarks about the complaints which I had made, I beg to say that I repudiate the idea that I made any complaints whatever in my paper—complaints in such a paper would have been out of place. I merely wished to advance general remarks, and to lay down ground for discussion upon the general question whether the Moncrieff system was well suited for application, combined with other systems, in future works. I beg to say I do not at all wish to go back, but to allude to future works; and I desire to raise the large general question, whether it is better to employ a system which is characterised by dispersion of the guns for harbour defence, in preference to blindly adhering to the existing system of massing them in large iron plated batteries. I think there is room for both systems, but I regret that one of them has its hand so deep in the national purse. It is the cuckoo in the sparrow's nest. I only hope that one of the chicks thrown out will somehow get fledged. I trust that the defences of the country may attract more general attention, and that my system may yet be more skilfully applied. In concluding allow me to say that I have considered the subject very carefully, and that I believe no more important question could occupy the minds of engineers, artillerymen, and others, who have the welfare of the country at heart.¹

¹ I regret that I forgot to answer Captain Horton's question. In reply to it, I now beg to say that in 1871 I was requested by the Secretary of State for War to give designs for the position referred to by Captain Horton, viz., Cliff End, for twenty guns. The following is briefly what was submitted.

My plans showed a ditch which could not be enfiladed by an enemy, enclosing a space well adapted for a small encampment, with a good well; there is a defensible barrack immediately in rear of the position. One caponier enfiladed the whole of

Captain OWEN: I have no wish to enter into a long explanation, but every artilleryman knows there are occasions when it is much better for guns to act *en masse* than separately. It has been felt over and over again.

Sir J. COODE, being called upon by the Chairman, said: I do not know that I have any particular remark to make. The views which were expressed in my paper read in this theatre a fortnight since met with such general approval on that occasion, and have not been objected to this evening, so that I do not know that I have anything further to say. As far as I recollect, not a single objection has been offered to it. So far, of course, it is satisfactory to me. Certain questions were asked on the last occasion, and those I answered to the best of my ability, and, therefore, I do not think I need detain the meeting, more especially at this late hour. I might, however, make one remark in reference to what fell from Captain Selwyn just now. He spoke of the difficulties that exist with regard to the purchase of land, and thought the same system which prevails with regard to obtaining land for railways might be adopted in the case of our land defences. Now, I think there is such an Act, called the General Defences Act, which is operative at any moment in case of difficulty. I entirely fall in with what has been said by Major Moncrieff, with regard to the importance of harbours as a means of increasing the strength of our Navy. There can, I imagine, be no question that strategical harbours will permanently increase the strength of our Navy. It should be borne in mind you can make a harbour like that at Portland, for the price of a *little more* than that of two ironclads; such a harbour at Fife would not only permanently increase the efficiency of any naval force that might be employed on a part of the coast where in time of war it would be most wanted, and also afford refuge in storms to the mercantile marine for all time. I think that is a point that should not be lost sight of.

The CHAIRMAN: I am sure you will all join with me in thanking Major Moncrieff for the interesting lecture he has given. I dare say he feels as I do, that it is a great pity there has not been a little more wholesome opposition to the views he has brought forward. I should like to make a few brief remarks on the discussion. Something was said about the slow fire of a battery—the slow steady fire of a battery may be very formidable. You know I am a Marine Artilleryman, and as such I would speak of the disadvantages broadside ironclad ships have to encounter from the smallness of their ports, which often must cause their fire to be slow. And if you read the account of the American War, you will find a good deal said about the *blindness of the monitors*. We are remedying this in our Navy to some extent by constructing ships to carry guns mounted *en barbette*.

Something was said about localisation for coast defence. I have long been of opinion that if you told the fishermen even of Clovelly, where the Royal Navy is not very popular, that they would never be moved from their homes, and that if they chose to go to drill, when war came, they would only be required to defend their own harbours, you would get plenty of volunteers; but you fail to attract them if you throw out any hints of distant foreign service. With regard to the question of Martello towers, and "diffusion of artillery," I think it would be a great pity if

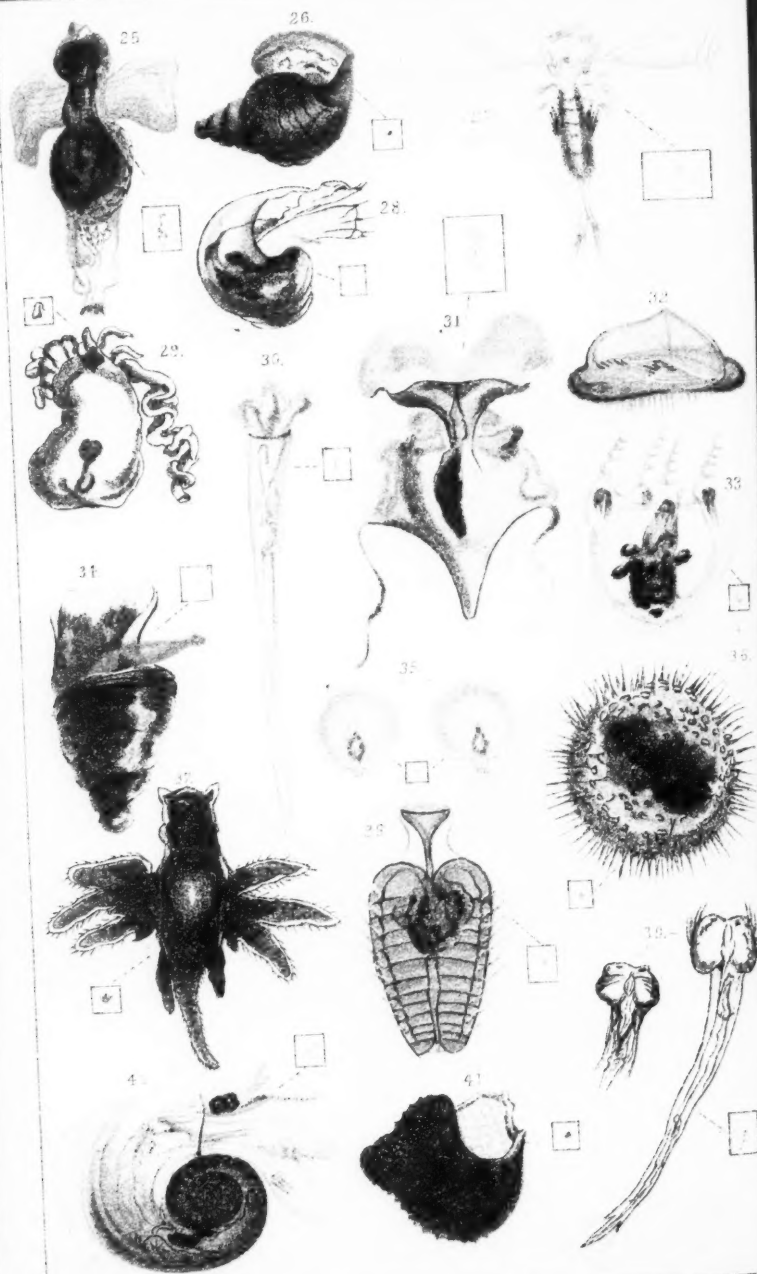
the ditch. The ground falls away to the rear of the position in a gentle slope, forming a slight valley, with another slope further back, all of which was commanded by lines of musketry, and by the guns, which were well dispersed.

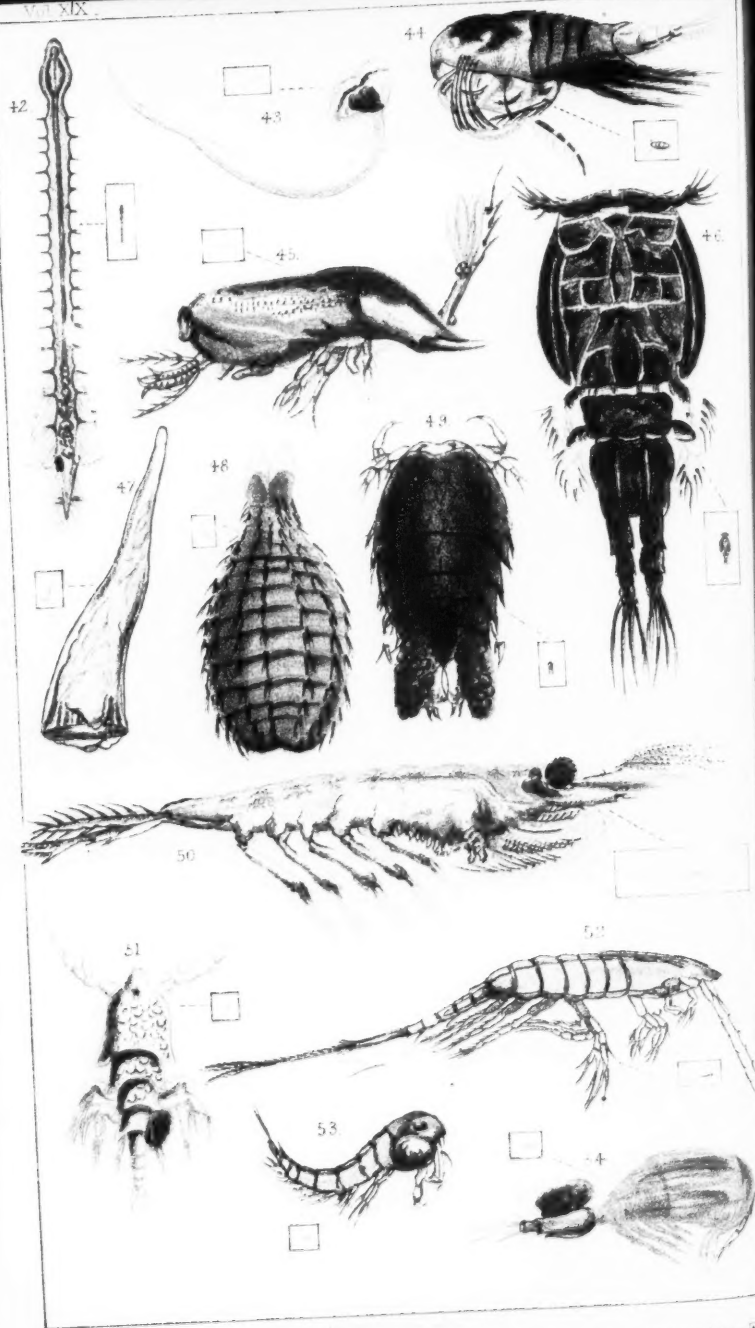
The important face of the battery on the West Cliff crossed fire with Hurst Castle to the west; and the guns on this face were all mounted on Moncrieff carriages, with a command varying from 60 feet to about 105 feet. The gun with the greatest command, with 5° depression, bore on the Channel at 360 yards from the nearest point of the sea wall; the same gun was about 900 yards from the end of How reef. The guns on the summit of East Cliff bore north, and were mounted *en barbette*, with a command of 125 feet.

In reference to the fourth *element of defence*, referred to in my paper, I also strongly urged for this position the application of my system of range-finding, &c., which, as stated, I consider the most important part of the Moncrieff system.—A.M.

wrong ideas were allowed to prevail on that subject. I perfectly agree with Major Moncrieff as to the advantage of having guns diffused over a large space of ground. I would not say, abolish Picklecombe or Bovisand, but I quite agree that guns in detached posts here and there would be of great use, and very difficult for ships to silence. But those guns must be within *hard hitting* distance of the object, and they must be under the perfect command of one mind. The whole system of defence must be organised; and when once we have made up our minds how to defend one of the ports, say Portsmouth or Plymouth, or a mercantile port, we ought to go to drill and see how it can be done, and how batteries, torpedoes, and gunboats can be made to work in concert. We ought to have a plan and system, so that when war comes, we may not have to improvise a system of defence. Something was said about gunboats. I am not a sailor, but I think there is a very important point about gunboats. You must have gunboats large enough to face a heavy sea. I doubt if many of our present gunboats could, for instance, keep a rendezvous at Beachy Head in very bad weather. With regard to Sir J. Coode's able lecture, I have only one remark to make. As was said by Captain Scott, in the question of harbours, we must not think of England alone. It is an *imperial*, not an *insular* question. Our fleet is perfectly useless without coal, and unless we have some posts for coaling at certain strategical points all over the world, and these tolerably well defended, our ships will not keep the sea.

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Vol

DELINEATIONS OF SOME MINUTE SEA-SURFACE
ANIMALS.—From Coloured Drawings by Mrs. TOYNBEE.

PART II.

For instructions regarding means of capture, examination, &c., see page 214.

PLATE III.

- Fig. 25. *Pteropod*.—Feb. 4th, 1868. Lat., 17.11 N.; long., 83.24 E. Current, N. 64 E., 15 miles. This Pteropod flapped its wings and swam about actively, the hairs round the tail were also in rapid motion.
- " 26. Dec. 7th, 1857. Lat., 25.53 S.; long., 82.23½ E. Current, S. 81 E., 7 miles. Temperature of surface water, 72.5°. Found this turretted shell, but was unable to see its inhabitant.
- " 27. May 2nd, 1857. Lat., 9.15 S.; long., 17.19 W. Current, S. 56 W., 5 miles. Temperature of surface water, 77.8°. The long hairs on the horns of this Crustacean and the shape of its head were very peculiar.
- " 28. Sep. 27th, 1857. Lat., 40.17 N.; long., 19.08 W. Current, N. 17 W., 6 miles. Temperature of surface water, 67.2°. Towed the net and caught many of these shells.
- " 29. Dec. 4th, 1857. Lat., 30.17 S.; long., 79.53 E. Current, N. 55 W., 4 miles. Temperature of surface water 68°. Found this flexible medusa?
- " 30. *Pteropod Larva*?—Feb. 3rd, 1858. Lat., 16.21 N.; long., 82.37 E. Current, N. 61 E., 14 miles. Temperature of surface water, 78.5°. Found this Pteropod? It had no wings, but arms with actively moving ciliæ, these arms were often extended much farther than shown in the sketch.
- " 31. *Hyalea*.—Feb. 4th, 1858. Lat., 17.11 N.; long., 83.24 E. Current, N. 64 E., 15 miles. Caught this delicate Pteropod; placed in a tumbler of water it swam actively.
- " 32. *Veilella*.—Dec. 1st, 1857. Lat., 31.34½ S.; long., 77.24 E. Current, N. 44 E., 17 miles. Temperature of surface water, 69°. During a calm we caught many of these Veilellas, its sail was placed at the same angle to the disc, from which it rose perpendicularly, as a ship's yards when braced sharp up. Several of them had shells of *Ianthina communis* attached to them; others were covered above and below with small barnacles; in these latter the tubes or feelers had entirely disappeared.
- " 33. *Gymnoththalmatus Medusa*.—March 26th, 1858. Lat., 1.08 N.; long., 82.37 E. Temperature of surface water, 82.8°. Found this small Medusa, which, by contraction and expansion, moved rapidly through the water.
- " 34. April 22nd, 1858. Lat., 27.29 S.; long., 52.51 E. Current, N. 2 E., 22 miles. Temperature of surface water, 75.1°. Found this minute shell amongst many others.
- " 35. *Noctiluca*?—April 6th, 1857. Lat., 34.18 S.; long., 25.31 E. Current, S. 49 W., 37 miles. Temperature of surface water, 65°. Towed the net and found it full of these globules; many were examined under the microscope, but this alone showed signs of life by changing its form as shown in the sketch.
- " 36. *Rhizopod*.—Oct. 2nd, 1857. Lat., 20.13 N.; long., 25.43 W. Current, 2 c


- N. 78 W., 13 miles. Temperature of surface water, 77°. Found this little ball, which had no apparent motion but floated in the water.
- Fig. 37. *Nudibranchiata*.—Dec. 26th, 1857. Lat., 1.05 S.; long., 85.13 E. Current in two days, S. 73 E., 58 miles. Temperature of surface water, 81.2°. Caught this *Glaucus*, which seemed to be of a gristly substance; it floated without apparent motion, but under the microscope the ciliae moved rapidly.
- „ 38. *Beroida*?—Nov. 27th, 1866. Lat., 5.48 S.; long., 81.28 E. Temperature of surface water, 80.2°. It had four rows of very large ciliae, mouth pedunculated, and an evident stomach. The ciliae moved most rapidly.
- „ 39. *Sagitta*.—May 6th, 1857. Lat., 0.34½ S.; long., 24.47 W. Current in two days, S. 21 W., 38 miles. Temperature of surface water 80.4°. To-day-the water was full of these creatures, all with delicate fan-tails, the one in the sketch had moving (by contraction and expansion) up and down its body two slug-like parasitic distomas, which continued in motion after the *Sagitta* itself was dead.
- „ 40. *Atlanta Heteropoda*.—May 23rd, 1857. Lat., 31.39 N.; long., 44.32 W. Current, S. 32 E., 10 miles. Temperature of surface water, 72.3°. This exquisitely delicate shell was perfect, excepting its keel. The part of the interior marked , was in rapid and constant motion, and the sucker-like tube outside contracted and expanded, moving about as if searching for food.
- „ 41. Dec. 21st, 1857. Lat., 5.52 S.; long., 81.10 E. Current, S. 31 W., 18 miles. Temperature of surface water, 80.9°. Found this shell, but did not see its inhabitant.

PLATE IV.

- „ 42. *Sagitta*.—Dec. 2nd, 1856. Lat., 3.30 N.; long., 88.55 E. Temperature of surface water, 80.2°. Caught this *Sagitta*? which evidently had vision, as it avoided any object brought near it. It moved by sudden darts through the water.
- „ 43. *Appendicularia*.—May 5th, 1857. Lat., 1.35 S.; long., 23.49 W. Temperature of surface water, 80°. It was found in the bucket but was dead when put under the microscope.
- „ 44. Jan. 8th, 1857. Lat., 15.43 N.; long., 82.06 E. Temperature of surface water, 77°. In the net was found this remarkable crustacean, which used its black paddles to "tread the water;" its fore legs moved up and down at right angles to the body.
- „ 45. *Larva of Copepod*.—Nov. 29th, 1856. Lat., 0.38 S.; long., 83.39 E. Temperature of surface water, 80.8°. Pumped up this crustacean, its eyes were well defined and its tail very remarkable.
- „ 46. *Crustacea Copepoda*.—May 9th, 1857. Lat., 3.49 N.; long., 28.02 W. Current, N. 50 W., 30 miles. Temperature of surface water, 79°. This creature was very thin and flat, its shell was marked and coloured much like the back of a tortoise. It was very active and clung to the sides of the bottle and tube.
- „ 47. *Annelid Larva*?—March 5th, 1857. Lat., 0.11 N.; long., 82.41 E. Temperature of surface water, 83°. Towed the net and found this substance, which, though motionless, seems to have possessed life.
- „ 48. *Beroida*.—March 2nd, 1857. Lat., 3.22 N.; long., 82.07 E. Temperature of surface water, 82°. Caught in the net several specimens of this *Beroida*. The one in the sketch kept its ciliae in constant motion. Some of them had not so many rows of ciliae.
- „ 49. *Crustacea Copepoda*.—Feb. 28th, 1857. Lat., 4.48 N.; long., 82.20 E. Temperature of surface water, 82.7°. Caught in the net this remarkable Crustacean. The blue appendages are the ova.

Fig. 50. *Crustacea Stomapoda*.

- „ 51. April 15th, 1857. Lat., 24.20 S.; long., 62.53 E. Current, S., 2 miles. Temperature of surface water, 77°. In the net found this active little *Calanus*, with a bunch of eggs attached to it.
- „ 52. *Crustacea Copepoda Setella*.—Jan. 25th. Lat., 15.32 N.; long., 82.25 E. Temperature of surface water, 77°. Pumped up this crustacean from about six feet below the surface; its motion in the water resembled the creeping of a small animal.
- „ 53. *Miracea Efferata*?—Feb. 28th, 1857. Lat., 4.48 N.; long., 82.20 E. Temperature of surface water, 82.7°. This seemed to creep in the water like No. 52. Great numbers of both sorts were caught; the colours in each case were identical, so also the legs and the position when dead, as shown in the sketch.
- „ 54. March 5th, 1857. Lat., 0.11 N.; long., 82.41 E. Temperature of surface water, 83°. Found this crustacean in the net, it had ova attached to its tail; many others of all sizes and colours, but of the same form, were in the net.